# STUDY OF THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY

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Jim Bradley
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# STUDY OF THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY

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## ABSTRACT

This study of the Environmental Protection Industry in Ontario provides an overview of the current economic activity generated in Ontario as a result of environmental regulations, the prospects for the growth of this industry, the impact of free trade on these prospects, and industry views on the potential role of the provincial government in maximizing the economic spinoffs associated with environmental protection activity. It also describes an accompanying forecasting model for use on personal computers which will be used by the Ministry to estimate the macroeconomic impact on the provincial economy of future environmental protection spending.

# TABLE OF CONTENTS

Page

Letter of Transmittal

Executive Summary ........................................................................1

Chapter 1: Introduction........................................................................3

Chapter 2: Methodology ........................................................................7

Chapter 3: Estimated Size of the Ontario EP Industry...................... 13

Chapter 4: Growth Trends and Prospects................................... 32

Chapter 5: Ontario Competitiveness and the Impact of Free Trade ...... 43

Chapter 6: EP Industry Issues and the Role for Government ............ 67

Chapter 7: Environmental Protection Impact Model........................ 76

Appendix I: Survey of Pollution Control Expenditures
Appendix II: Sample Output from the EP Impact Model
Appendix III: Listing of Firms in the Ontario EP Industry
Appendix IV: Mail Survey Questionnaire

Annotated Bibliography

# STUDY OF THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY

## EXECUTIVE SUMMARY

- This study of the Environmental Protection (EP) Industry was intended to provide an overview of the current economic activity generated in Ontario as a result of environmental regulations, the prospects for the growth of this industry, the impact of free trade on these prospects, and industry views on the potential role of the provincial government in maximizing the economic spinoffs associated with EP activity. In addition, the report contains a model which will be used by the Ministry to estimate the economic spinoffs of future EP spending.

- For the purposes of this study, the EP **industry definition** included private sector Ontario manufacturers or service suppliers of specialized EP goods and services, and the suppliers of the construction involved in equipment installation. General industrial products used in the course of EP activities are included in our economic impact model, but not in the discussions of the scale and trends in the EP industry. Since the boundaries of what constitutes an EP product are necessarily somewhat arbitrary, estimates of the scale of activity in this sector are at best approximations of any given definition of the industry.

- **Data** were gathered for this study from discussions with over 100 buyers and sellers of EP goods and services in Ontario, from a large sample mail survey of EP goods and service suppliers, and from a review of existing literature on the EP industry in Ontario, Canada and the United States. With the exception of construction, official statistical sources were not very useful for estimating EP activity, since the aggregations used do not allow for the identification of EP products.

- Based on our survey results and the available literature, we conclude that the EP industry is a significant source of **sales revenue** and **employment** in Ontario. Roughly 28,000 Ontarians are employed in the generation of about $2 billion in annual sales of Ontario-produced products and services, including equipment, instruments, and supplies and waste disposal, treatment, recycling, consulting and analytical services. In terms of employment, the EP industry is similar in size to the clothing, wood and communications equipment manufacturing industries. **Exports** by our mail survey respondents totalled $67.8 million, or 13.5% of their total sales.

- **Growth** by firms in this sector has been quite strong during the current economic recovery. The firms responding to our mail survey reported growth rates of 17% to 32% per year since 1983, with the fastest growth reported in the water and wastewater field. (All growth rates are unadjusted for inflation.)

- **Growth prospects** are expected to be quite favourable over the next five years, as both purchasers and suppliers anticipate further advances in

EP demand in response to tightening government regulations. Survey respondents expect annual growth ranging from 15% in the air pollution field to over 18% in water and wastewater treatment.

- **Free Trade** is expected to be modestly beneficial to the Ontario EP industry, and will give a boost to export-oriented equipment manufacturers and consultants. The industry is quite competitive in serving the Canadian demand in specific market niches. In the goods sector, Ontario firms are in the strongest competitive position in either low-volume, high technology products, where scale economies are not significant, or in high-volume low technology items that would bear significant freight costs if imported or which require major customized assembly on-site. High technology items and general industrial goods that are produced with significant scale economies are already largely imported. Ontario consulting engineering firms have strong competitive capabilities in the EP field. Other services, such as waste hauling, must be performed by local branches of companies, whether Canadian or foreign based.

- The most important area of **government policy** affecting the EP industry is in the setting of environmental protection regulations. Purchasers believe that they will be able to meet the new air and water quality regulations provided they do not go further than existing U.S. standards, but they are uncertain as to whether or not this will be the case.

- Suppliers generally feel that Ontario's new regulations will merely match U.S. standards. According to suppliers, one of the **problems facing the Ontario EP industry** is that following the American lead in setting standards has been harmful for the development of the EP industry in Canada. By leading in regulations (if not necessarily in enforcement) a country stimulates the development of EP products that can later be exported. Other problems cited include purchasing decisions by U.S. multinationals that call for the replication of equipment used in parent company plants, a conservative approach by governments to permitting the use of experimental control technologies, and U.S. government sector purchasing preferences for American-made products.

- Suppliers favour greater support by the government for new product development, through financial support for R&D and marketing, and greater flexibility in the approvals process to permit pilot projects with innovative approaches to environmental protection.

- Accompanying this report is an **Environmental Protection Impact Model**, designed to estimate the direct, indirect and induced economic spinoffs of EP spending on Ontario incomes (GDP) and employment, using and input-output approach. The final chapter of the report is a guide to the use of this microcomputer-based model.

## STUDY OF THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY

## CHAPTER 1
## INTRODUCTION

### 1.1 Background

The Ontario Ministry of the Environment has undertaken a number of recent initiatives to improve the monitoring and abatement of industrial and municipal effluents in the province. Some of these measures, and possible additional regulatory changes now under consideration, require significant expenditures by private companies, utilities and municipalities in order to meet the new tougher standards for environmental control.

Opposition to such measures frequently centres on the financial burdens they impose on the affected companies and municipalities, and more broadly, on the economic costs that tighter regulations could entail including losses in employment, incomes and tax revenues in the province.

While these considerations are important, and properly ought to be evaluated in developing appropriate standards, so too it is essential that any such cost analysis fairly presents *net* cost and benefits to the overall economy. Even where direct economic costs result from environmental regulations, there may be significant offsetting economic benefits. For example, direct savings in health care, agriculture and other areas could result from improvements in environmental control.

Environmental regulations are tied to a sizeable amount of economic activity in the province, in the provision of pollution control equipment, materials and services. Some or all of this activity represents a transfer of economic activity from other sectors of the economy, since the need to devote investment funds to meeting environmental regulations may lower rates of return and thereby reduce industrial investment spending.

The production of pollution control equipment and services generates spinoff activity in supplying the machinery and materials used by the EP industry, and in the consumer spending generated as the result of wage payments to employees in the pollution control sector. Even where the equipment involved is produced outside the province, a major share of the required environmental control spending may be directed at engineering, design and consulting services provided by Ontario firms.

Public policy-makers would find it useful to be able to generate quantitative estimates of these resulting economic spinoffs of regulatory changes. Such analyses have already been conducted with respect to environmental protection (EP) spending in other jurisdictions. (See for example, OECD (1985) and references contained therein.)

The correct balancing of economic costs and benefits resulting from environmental protection is one of the most difficult areas of public policy formulation. The measurement problems that must be addressed are highly complex. Furthermore, there are very little data available on environmental protection spending and production in Canada, and there is clearly a need for a much more directed effort at assembling such data by official statistical agencies. Finally, there is a need for an acceptable approach to estimating costs and benefits.

This report does not attempt to address the costs and benefits of environmental protection. Rather, it focuses on the production of EP goods and services in Canada, and the extent to which the spending associated with environmental protection activities are transferred to firms in Ontario, as opposed to import suppliers, and on the nature of the industry that has been created in Ontario in response to the demand for environmental protection products.

Environmental protection activities are those designed to reduce or avoid emissions of materials that are detrimental to the environment. The EP industry includes suppliers of equipment and services for air pollution control, water and wastewater treatment, solid waste disposal and recycling, and monitoring and analyzing environmental data. For the purposes of this study, the EP industry definition included private sector Ontario manufacturers or service suppliers of specialized EP goods and services, and the construction involved in equipment installation, as well as engineers and other consultants who provide advisory services on EP matters. General industrial products used in the course of EP activities are included in our economic impact model, but not in the discussions of the scale and trends in the EP industry. Resource conservation, nuclear waste management and noise abatement activities are excluded from this definition, and we do not attempt to measure the direct employment and value added generated by EP personnel at government environment departments or public utilities.

## 1.2 Objectives of the Present Study

In view of the varied needs discussed above, the Ministry of the Environment asked Woods Gordon to prepare a broad study of a number of aspects of the pollution control industry in Ontario.

This report meets a number of distinct objectives. First, to address the paucity of data on the production of environmental protection products in the province, the study provides an initial overall assessment of the scale and economic importance of the production of EP goods and services in Ontario, as a first step towards improved census or survey efforts by official statistical agencies. In addition to developing an understanding of the current scale of activity, the report presents the views of both purchasers and suppliers of EP products and services on the future growth prospects for this area of economic activity.

Second, the report develops an input-output methodology for estimating the impact of future EP spending generated by regulatory change on the Ontario economy. This economic impact framework will prove to be a useful tool for in-house analysis by the Ministry of the Environment's economics and policy staff.

Third, the long-term prospects for the EP industry in Ontario will be affected by broad structural changes in the provincial economy and the global trading environment. The recently concluded Canada-U.S. Free-Trade Agreement, if approved by the legislative branches of both countries, will be a key driving force in the medium and longer term prospects of many industries in the province. This report addresses the implications that free trade will have for EP producers and their major sources of demand.

Finally, the report provides an improved understanding of the potential role for government initiatives to support Ontario companies in this field. In the course of extensive discussions with both purchasers and suppliers of environmental protection products, we obtained the viewpoints of market participants on the means by which the effective implementation of new regulations and the development of a strong Ontario EP industry could be promoted by the government. These views should serve as a useful supplement to the extensive, ongoing industry consultations being undertaken by the Ministry.

## 1.3 Organization of this Report

Including this Introductory Chapter, this report comprises seven chapters. Chapter 2 reviews the methodology undertaken to gather quantitative and qualitative data on the environmental protection industry. Chapter 3 summarizes our findings on the overall size of the environmental protection sector in terms of revenue and employment in Ontario. Chapter 4 discusses the recent trends and medium term outlook for growth in the EP sector and its various components. The impact of the Free Trade Agreement on these prospects is reviewed in Chapter 5. Chapter 6 discusses our findings on the potential role for government policies in promoting the growth of the EP industry in the province. The final Chapter presents our Environmental Protection Impact Model, which is intended to be used in future research on the economic impact of environmental expenditures.

# CHAPTER 2
# METHODOLOGY

## 2.1 Introduction

No comprehensive data source exists for the environmental protection industry in Ontario. Most of the activity in this sector is undertaken by firms involved in a range of non-environmental manufacturing and service activities, and is therefore incorporated into broader industry categories by statistical agencies. Data on expenditures on environmental protection (as opposed to Ontario production of EP products and services) is also available only in an incomplete form, with public sector spending tracked more comprehensively than private spending.

It was therefore necessary for the purposes of this study to undertake for the first time a significant effort at obtaining new quantitative and qualitative perspectives on this sector in Ontario. This data was gathered using four different approaches:

(1) a review of existing related literature and statistical sources;

(2) interviews with 75 purchasers of EP products/services;

(3) a mail survey sent to over 1,800 Ontario firms identified as possible manufacturers of goods or suppliers of services for environmental protection; and

(4) follow-up interviews with 30 suppliers of EP products.

Our interview samples were drawn from a wide range of purchasing industries and municipalities, and from suppliers of various products and services for air, water and solid waste pollution control.

A wide range of products and services are used in the course of environmental protection activities. In order to have a well-defined industry for public policy purposes, we have defined the EP industry as including all products and services for which environmental protection is the dominant application[1]. Thus, while sewage treatment equipment is included in our definition, the pipes and valves that connect such equipment to the sewage collection system are excluded. This is similar to the approach adopted by official statistical agencies, who would include a mufflers company in the auto-parts industry, but not a manufacturer of fabrics that are sometimes used for car seats. In our economic impact model, however, where the purpose is to fully capture all of the economic spinoffs from environmental projects, we include expenditures on these general industrial commodities.

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[1] Environmental protection is in turn defined as, following the report of the Institute of Research on Public Policy, "any activity which has as its major effect the reduction or avoidance of emissions of materials that ... may become detrimental to the environment". As noted by the IRPP report, it would be impractical to

The remainder of this chapter reviews the specifics of each of our quantitative and qualitative data gathering procedures. The methodology used in the creation of the Environmental Protection Impact Model is presented along with the manual for using the model in Chapter 7.

## 2.2 Literature Review

Our literature review covered both published and unpublished reports on the environmental protection industry in Ontario, Canada and other countries. A very large body of literature is available on very specific aspects of environmental protection engineering and technology. Our focus, however, was on the somewhat smaller group of reports on the economic aspects of the environmental protection industry and the scale of activity in various jurisdictions. The literature used in the preparation of this report is listed in the Annotated Bibliography.

Data are also available from Statistics Canada figures on capital expenditures for which firms claimed accelerated capital consumption allowances, under tax law provisions allowing special treatment for water and air pollution control assets. We were advised by officials in the relevant department of Statistics Canada that data obtained by this method would provide a misleading picture of actual pollution control expenditures. Similarly, officials at the Approvals Branch of the Ontario Ministry of the Environment advised against using their data to estimate expenditures, since many firms do not report project costs.

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conduct a survey of suppliers of all goods and services used, however remotely in EP activities, since "cooperating with a survey (would be) a low priority" for such suppliers."

## 2.3 Survey of Purchasers

The survey of purchasers was intended to provide an indication of the types of products and services demanded, the role that Ontario firms play in meeting the needs of these purchasers, the views of purchasers as to the future growth in their environmental protection spending, and the impact of bilateral free trade on the Ontario environmental protection industry.

The 75 individuals contacted in our survey were generally those with the prime responsibility for environmental protection at their establishment, as identified by senior officials at their companies. Their organizations span a range of industries that tend to purchase significant volumes of environmental protection products. In the case of a few large organizations, more than one individual at the organization was included in the survey. The industry breakdown of the respondents is as follows:

| INDUSTRY | # OF RESPONDENTS |
|---|---|
| Food and Beverage | 2 |
| Wood Products | 3 |
| Non-Metallic Minerals | 4 |
| Petroleum Refineries | 5 |
| Pulp and Paper | 5 |
| Mining | 6 |
| Metal Refining and Smelting | 8 |
| Chemicals | 11 |
| Consulting Engineers | 15 |
| Public Sector (Government Departments and Agencies) | 16 |
| TOTAL | 75 |

Based on the early interview results, we skewed the sample toward consulting engineers, who are much more frequently involved with large scale installations of new equipment than are engineers at any individual industrial establishment. Consulting engineers usually play the key role in specifying the equipment to be purchased for such installations. Thus, their impressions of Ontario, Canadian and imported equipment are particularly valuable in estimating market shares. One should note that, although the total sample should provide a reasonable representation of the views of purchasers, responses related to industry-specific items may not be representative of the industry involved, in those cases where we have sampled only a few firms (e.g., food and beverage and wood products).

The public sector sample included municipal water and solid waste management officials, as well as provincial officials who are the leading purchasers of monitoring instrumentation. We also discussed industry trends and developments with officials at the federal Department of Regional Industrial Expansion (DRIE), who have been engaged in ongoing work on this sector.

## 2.4 Mail Survey of Suppliers

In order to obtain a broad-brush view of the activity of environmental protection firms in Ontario, we conducted a large-sample mail survey of Ontario EP goods and services suppliers in the spring of 1988. The purpose of the survey was to obtain an indication of the scale of the industry in the province, its employment, recent growth trends and future growth possibilities, and product-range.

The focus of this aspect our study was to obtain an understanding of the scale and prospects for the EP industry in Ontario. Thus, in contrast to the limited body of existing work that has been directed at estimating the value of EP goods and services *purchased*, our emphasis was on the even more difficult task of obtaining data on the nature of EP industry *production* (with significant Ontario content).

Since any survey (perhaps with the exclusion of a census undertaken by statistical agencies which must be completed by law) will achieve only a partial response rate, and no fully-comprehensive list exists for all firms that are in part involved in the environmental protection area, our results were not expected to provide complete coverage for any of the indicators sought. Further, private companies responding to some questions often tend to be reluctant to disclose sales data on individual product lines. However, our findings provide a lower-bound for the scale of the industry in Ontario, and suggest the potential merit in having a census conducted by Statistics Canada in this area.

The survey was intended to cover a broad range of firms in the environmental protection sector. For goods-producing firms, our focus was on firms that are engaged in manufacturing within the province. We did not include the activity of wholesalers and distributors, since this would risk double-counting Ontario manufactured products at later stages of distribution, and would include virtually all imported goods in the EP industry, which are almost always distributed through a local office.

We also did not include the large number of firms for whom environmental protection constitutes a small part of their overall operations. This would apply, for example, to construction contractors, pipe and valve makers, chemical companies and a wide range of other manufacturers of industrial products. In the case of industrial construction firms, much of their activity in this area would be in the construction of water and sewage treatment facilities. Since this work must take place locally, and therefore inevitably involves Ontario workers, the activity and job creation in this area was more easily and comprehensively captured by existing data on public expenditures on such facilities.

The list of respondents was compiled from two sources. The primary source was a directory of environmental protection firms in Canada assembled by William Glenn (1987), based on trade magazine listings, association memberships, government laboratory listings and other sources. This list, included in Appendix III, identified over 1,700 firms in Ontario in the broadly-defined environmental protection sector, including firms in twelve categories:

(1) consulting/engineering
(2) air pollution control equipment
(3) water pollution control equipment
(4) other pollution control equipment
(5) treatment chemicals
(6) solid waste handling
(7) liquid waste handling
(8) waste treatment and disposal
(9) laboratories
(10) recycling
(11) training
(12) biotechnology

A check against a number of other listings obtained by Woods Gordon from various trade journals and associations confirmed that the Glenn list was reasonably comprehensive in most of these categories. The only exception appeared to be in the area of air pollution control products, where the number of identified firms appeared to be too low.

We therefore supplemented the Glenn list with firms identified by *Made in Ontario* (1987) as manufacturers of air pollution control equipment. This added a further 107 firms. In total over 1,800 firms were sent the survey, although, as we discuss in the next chapter, a portion of these firms turned out to be distributors rather than manufacturers of EP products, or were selling products and services that were only tangentially or infrequently related to environmental protection applications.

The responses received were carefully reviewed prior to the tabulation of the results. In some cases, the description of the firm's products indicated that the product code listed by the firm was incorrect; these codes were corrected to match the actual product of the firm in question. In other cases, a miscellaneous category was used; we then used the description of the product to categorize the firm's output.

## 2.5 Supplier Interviews

In order to follow-up on the results of our mail survey, estimate the scale of activity undertaken by firms that would not respond to the mail questionnaire, and respond to the need for more qualitative data, we conducted discussions with 30 equipment and service suppliers for air, water and solid waste pollution control. Most of the firms contacted are leaders in their respective fields; a few were small, high-growth companies producing specialized lines of equipment.

The discussions with suppliers were focussed on the competitive conditions facing Ontario firms in this sector, the potential impact of free trade on environmental protection goods and service production in the province, the growth prospects for the industry, and on the potential role for the provincial government in fostering this growth.

# CHAPTER 3
# ESTIMATED SIZE OF THE ONTARIO ENVIRONMENTAL PROTECTION SECTOR

## 3.1 Introduction

As we have noted, the environmental protection industry is not a well-defined sector of the Ontario economy in terms of statistical data from official sources. The industry spans a range of goods and service-producing activities, the activity of which is incorporated into broader industrial aggregates. Many of the firms involved in this sector, including equipment manufacturers, chemical suppliers, consultants, and other service providers, are also extensively engaged in non-EP activities; in many cases, environmental protection sales are only a small component of the firm's revenue-generating activities.

Our mail survey of EP firms in Ontario, supplemented with information gathered in the course of our interviews with industry participants and a search of existing literature, provides an indication of the scope of EP activities in the province. *Our findings suggest that the EP sector is a significant contributor to the provincial economy, with a quite conservative estimate for industry sales on the order of $2 billion per year, and directly employing roughly 28,000 Ontarians.*

## 3.2 Industry Definition and Segmentation

A wide range of products and services are devoted to disposing or recycling waste products, water treatment, environmental clean-up and other EP purposes. There is no perfect method of dividing the firms providing these products and services into identifiable and wholly distinct segments, since, as noted in the report, *Defining the Environmental Protection Industry* (Institute for Research on Public Policy (1987)), waste products often may pose problems for more than one part of the ecosystem. Many wastes, for example, may be emitted into the water, disposed of in landfill, or burned and thereby enter the air. Thus, environmental problems that could be viewed as an aspect of water pollution control become issues for solid waste or air pollution control as well. It is thus not clear, for example, whether a firm disposing sludges left behind from water treatment should be considered part of the solid waste industry or the water treatment industry, or whether a firm building an incinerator to burn solid waste is part of the solid waste sector, or part of the air pollution control sector.

For the purpose of this report, we have usually divided environmental protection activities into three segments: air pollution control; potable water and wastewater treatment; and solid and hazardous waste. Occasionally, we separate instrument manufacturing and environmental consulting from these broader categories.

The non-specialized nature of some of the equipment used in pollution control is well known. Valves, pipes and fans used in pollution control facilities may be much more widely applied in general industrial applications. Similarly, although there are specialized environmental service providers, the assembly and construction of environmental protection facilities (for water-related projects in particular) is handled by general industrial contractors.

As we noted in the previous chapter, we have adopted a middle course in terms of our definition of the environmental protection industry. For the purposes of industrial policy formulation, one would wish to have a definition of the industry that focuses on true environmental protection products and services, rather than on the much greater number of products that are applied along with pollution abatement equipment as a part of large water and waste systems. For these policy purposes, it would be meaningless to include a pipe or valve maker, for example, as part of the EP industry, and make such a firm eligible for any special industrial development initiatives. For most of this report, therefore, we restrict ourselves to dedicated EP equipment and services (including the construction involved in equipment installation) in defining the industry.

This was also the most pragmatic approach for our industry surveys. Since environmental protection accounts for only a modest percentage of the total demand for most non-specialized equipment, it was impractical to include these products in most aspects of this study of the environmental protection goods and services. We therefore focussed our data gathering and analysis on the more specialized products with a substantial degree of application to environmental protection.[1]

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[1] The decision on which products to include must be somewhat ad hoc. Our selection of firms corresponded to that developed by W. Glenn, *op. cit.*, after consultation with the Policy and Planning Branch of the Ministry of the Environment.

In terms of measuring the economic impact of environmental protection spending, however, one would want to include all of the spending on non-specialized industrial goods and services that is generated in conjunction with the installation of new EP products or the use of EP services. Therefore, our Environmental Protection Impact Model (described in Chapter 7) allows for the input of data on these broader expenditures when estimating the economic spinoffs from pollution control and monitoring activities.

### 3.2.1 Air Pollution Control

The air pollution control sector consists of firms which manufacture equipment for desulphurization and denitrification, dust collection, filtering, fume collection and other abatement processes, suppliers of monitoring and analysis equipment and instruments, and service firms providing consulting engineering and analysis.

A wide range of equipment is used in the course of the control and monitoring of air quality. This includes specialized equipment, such as electrostatic precipitators, scrubbers, and cyclones, as well as a large variety of more basic pumps, filters, valves and other industrial equipment and structures that are used in conjunction with more specialized air pollution control products.

Among the types of equipment now in use are the following:

*Electrostatic Precipitators* – devices designed to collect particulate matter out of gases through the use of electrically-charged rods. They contain some electronic components, but are not a very high-technology product.

*Baghouses* – another method to trap particulates, in which the incinerator emissions are forced through a chamber containing cloth bags. Among its other components are valves, iron walls, temperature sensors, and flow measurement devices.

*Scrubbers /Washers* – a method of cleaning emissions, made up of (for wet scrubbers) spray nozzles, jets of water, lime, a steel box, valves, a water pump, flaps and temperature controls and pressure sensor instrumentation. This is also not a very high technology product.

*Cyclones* – a method of swirling gases (using fans or a spinner) to cause heavier particles to settle. This appears to be a less popular method in terms of recent purchasing and installation in Ontario, and does not effectively control smaller particles. There are other similar devices that come under the general category of inertial separators.

*Incinerators* – devises used to burn off waste gases. (Incinerators used to burn solid or liquid wastes are *users* of air pollution control equipment.)

Among the firms identified as suppliers of air pollution control equipment by Ontario purchasers we contacted were (in no particular order) Wheelabrator (now part of Henly), Peabody Engineering, Flakt Canada, AVC Specialists, Cadre, Dukon-Mikropul, Emtrol-Cassier, Ceilcote (part of General Signal), Research-Cottrell, Joy, Farr, Carborundum (a subsidiary of Flakt), N.R. Murphy, and American Air Filter.

Instruments, consulting engineering services and industrial contracting services, are also purchased for air pollution control. Instruments include gas samplers, filter samplers, gas analysis equipment, and meters. Consultants assist in the design, selection and installation of equipment, and in monitoring, atmospheric modelling and testing services. Industrial construction contractors are used when major facilities (stacks etc.) are built. Most large industrial firms that purchase air pollution control equipment and services also directly employ environmental engineers as a part of their efforts to control air and water emissions.

### 3.2.2 Potable Water and Wastewater Treatment

The potable water and wastewater treatment sector consists of those firms which manufacture water purifiers, demineralizers, decanters, digesters, dewatering presses, clarifiers, filters and other water treatment equipment, producers of instruments, chemicals and other supplies, and firms providing consulting, testing and other services.

Much of the equipment purchased for potable and waste water treatment is composed of non-specialized industrial goods such as pipes, valves, pumps, motors, chemicals and metal tanks. As such, it was more difficult than in the air pollution field to identify suppliers for whom the water pollution control equipment field accounts for a significant part of their business.

Major purchasers of such equipment include governments, pulp and paper companies, chemical plants, refineries, and metal refining and smelting. Municipal governments are in total the largest single market segment, purchasing equipment and services to treat drinking water and sewage effluents. Industrial users treat water to make it suitable for their manufacturing processes (for example, in the paper industry), and then treat the wastewater before it is discharged. Some air pollution control processes also use water which must be treated before it is discharged.

Among the types of equipment now in use in the province are:

*Aerators* – devices that add air in order to speed up bacteria growth and metabolism to break down pollutants more rapidly.

*Gravity Sedimentation Devices* – Clarifiers (which remove haze or small particles from liquids), Flocculators (methods of causing particles to clump together so that they can be separated from liquids by settling, skimming or other means) and other equipment used to separate solids from liquids using gravity. These devices are in turn composed of tanks, rakes and other fabricated metal parts, motors, weirs and basic pipes, valves and other water system components.

*Filters/Screens/Strainers* – various devices, made of a wide variety of materials, designed to separate solid particulates from liquids by blocking particles above a certain size.

*Centrifuges* – devices that use centrifugal force to remove particles of solids in a liquid.

*Chlorination Equipment* – used to control the addition of chlorine to water for purification. Other chemical-feeding and mixing equipment is used in conjunction with chemicals used in sewage and water treatment.

*Sludge Processing* – collectors, conveyors, digesters, aging ponds, incinerators, shredders, thickeners and disposal units (heat treatment, wet-air oxidation, or pressure filter) for sludges.

*Tanks, Liners, Pipes, Fittings, Pumps, Valves, Motors, Compressors, Hoses* – basic components of fluid control systems, while not produced by the EP industry, form a large part of water and wastewater installations.

*Instrumentation* – used to measure, record or control water levels, rates of flow, water quality, dust levels, temperatures, weights and so on.

*Chemicals* – a wide variety of chemicals are used for water treatment (disinfection, neutralization, softening, algae control, pH control, fluoridation, deodorizing, etc.) and sewage treatment (bulking control, coagulation, corrosion control, dechlorination, dewatering, disinfection, pH control, sludge conditioning, deodorizing, etc.).

Among the large list of suppliers used by the purchasers we surveyed are Moyno, Dorr-Oliver, Robins & Meyers, Degussa, Tad Co. Engineering, Aer-O-Flo, Control & Metering, DuPont, Marlow, Pacific Flush, Hankins, BIF, Flygt, Worthington, General Electric, Crane, Canron, Brier Hydraulics, Westinghouse, Jenkins Valves, Allied Collieds, Alcan, Emco Supply, Munroe, Leitch, Dezurik, Knifegate, Rockwell, Bauer, C-I-L, Stanchem, Gould, Wemco, Westburne, Bristol-Meyers, Dominion Steel, London Steel, Spencer Turbines, Hoffman, Fram, and Ingersol Rand. Many of these firms are manufacturers of a wide range of industrial products rather than specialists in water treatment.

Services supplied in conjunction with these and other types of equipment include industrial contracting, consulting engineering, sampling and testing, cleaning and maintenance services. Some of the consulting firms are local offices of international firms.

### 3.2.3 Solid and Hazardous Waste

This sector consists of manufacturers of compactors, incinerators, composting systems, and other waste disposal equipment, specialized incinerators, plasma arc furnaces and other equipment for the handling and destruction of hazardous wastes, and service firms involved in the collection and disposal of solid and hazardous wastes, and consultants providing assistance in testing and monitoring, materials handling and process design.

Solid waste equipment is used to collect, haul, and process a wide range of waste materials. Such equipment includes trucks, bulldozers, compactors, balers, loaders, containers, weighing systems, conveyors, cranes, incinerators, packaged sewage treatment systems and separation machines. Some facilities used the heat generated by incineration to create steam for heating buildings or for industrial processes. As in other environmental protection areas, many items with broader industrial purposes play a role in the handling and processing of solid wastes.

Among the equipment suppliers identified in this sector by purchasers are Duke, Mobil, Vacusweep, Cambridge-Frink Canada, Amertech, Mack, Shu-pak, and Sanivan.

Many of the services in solid waste treatment and disposal are provided by the government sector. Private suppliers provide dumpster hauling, waste oil hauling, hazardous waste handling, groundwater testing, environmental impact studies, and recycling services. These service suppliers are also major equipment purchasers. Among the leading waste management service firms are Tricil, BFI, Waste Management Inc., Wasteco and Laidlaw.

## 3.3 Number of Firms and Industry Size

### 3.3.1 Mail Survey Results

There are over 1,800 firms involved in the supply of environmental goods and service production in Ontario. Appendix III to this report is a listing of Ontario firms developed by Glenn (1987). A more recent listing, developed on behalf of Environment Canada (1988) identified 1,661 firms in Ontario that were involved in environmental protection.

Some of these firms, however, are not engaged in manufacturing products in Ontario or supplying services for EP uses. Our survey results indicated that several hundred of these firms are essentially distributors of the products manufactured by other Ontario or Canadian firms or imported from the U.S., Europe or the Far East. Other names on these lists were gathered from trade publications that are now out of date, and the firms listed are no longer in business or engaged in EP activities. We estimate that the universe of domestic manufacturers of reasonably specialized EP goods or service firms is on the order of 1,200 firms.

Table 1: *Mail Survey Results*

REPORTED SALES OF ONTARIO EP GOODS AND SERVICES 1987

| Product/Service | Number of Firms In Category* | 1987 Sales |
|---|---|---|
| **Air Pollution Control** | | |
| Equipment | 18 | $18,079,200 |
| Instruments | 9 | $18,600,000 |
| Services | 30 | $10,723,479 |
| **Total** | **57** | **$47,402,679** |
| **Water and Wastewater Treatment** | | |
| Equipment | 27 | $92,132,264 |
| Instruments | 8 | $4,435,000 |
| Supplies | 3 | $2,010,000 |
| Services | 34 | $30,254,887 |
| **Total** | **72** | **$128,832,151** |
| **Solid and Hazardous Waste Disposal and Treatment** | | |
| Equipment/Instruments/Supplies | 21 | $30,376,980 |
| Solid/Hazardous Waste Disposal and Destruction Services | 16 | $129,506,791 |
| Recycling Services | 12 | $145,799,246 |
| Consulting, Other Services | 34 | $20,271,820 |
| **Total** | **83** | **$325,954,837** |
| **TOTAL ALL PRODUCTS/SERVICES** | | |
| | **143** | **$502,189,667** |

* Sales are classified by the commodity category which accounts for the largest share of the firm's Ontario EP goods and services production within the sector (air, water, waste). Since some firms are active in more than one of these three sectors, adding the three subtotals for the number of firms in each sector would double count such firms.

In total, of the 261 firms who responded to our survey, 164 indicated that they were involved in EP activities and provided sales and/or employment data, and 143 provided sales data. Of the remaining replies, 64 indicated that they were not in fact involved in EP manufacturing or services in Ontario. The others supplied some data on products and growth projections, but did not report sales or employment. The list of firms with complete responses includes many of the largest firms in this area and a large number of small service sector firms.

The respondents to our survey sold over $0.5 billion in Ontario-produced environmental protection products and services in 1987. The breakdown of these sales by the firm's primary EP commodity (including services) within each class of pollution control is shown in the table on the preceding page.

In addition, some firms reported employment levels in environmental protection activities but did not complete the sales figures. Based on the average ratio of employment to sales in the EP industry of firms reporting both figures, we estimate that the 239 employees in these firms account for an additional $23.8 million in EP sales.

These sales figures are generated by firms producing products and services with a high degree of Ontario content. Only 10 firms, primarily instrument manufacturers, reported less than 50% Ontario content in their Ontario-made products. This is not surprising, since services account for a significant share of the total EP production in the province, and since our survey excluded distributors of imported products.

The overall sales of EP goods and services in the province is of course much higher than the figures generated in our sample of respondents. As outlined in the next sections of this report, we considered a number of other statistical sources[1] in an effort to obtain an understanding of the overall level of activity in environmental protection in the province. Based on these data sources, our survey responses, a review of the list of respondents and non-respondents in light of our knowledge of the leading industry participants, and our discussions with over 100 industry participants, we have developed necessarily rough estimates of the annual sales volume of the Ontario EP industry by major category. These estimates should be viewed as conservative (i.e. low) ranges for the scale of the various types of EP activity in Ontario. They provide a useful indicator of the importance of the overall environmental protection sector to the provincial economy.

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[1] Including Smith (1978), MacLaren (1979), Statistics Canada (1987), DRIE (1987a), DRIE (1987b), Ropes and Lorenz (1986), Canadian Association of Recyclers (1987), Management Information Systems (1986), F.A.C.E. (1984), and Glenn (1987).

In the following sections, we review our findings on the scale of individual segments of the EP industry, before turning to our estimate of the scale of the EP industry as a whole.

### 3.3.2 Equipment, Instruments and Supplies

Our survey identified Ontario production of over $165 million in equipment, instruments and supplies for environmental protection. We believe that many of the largest manufacturers are included in our respondents to the survey, but based on our interview program, we feel that we have only accounted for 1/2 or less of the total.

A study by James F. MacLaren Ltd. (1979) on the pollution control *equipment* industry in 1978 estimated (based on a series of interviews) that the total market size (as opposed to production) in Ontario was $177 million per year (or 48% of the $369 million size of the Canadian market). Of this total, $100 million was in water and waste water, $35 million in solid waste, $33 million in air pollution and $9 million in noise abatement equipment. Smith (1978) estimated that the total Canadian sales of water and air pollution control equipment in 1977 were $189.3 million. Although the EP equipment industry may have declined during the 1981-82 recession as a result of the collapse of capital expenditures in Ontario, our survey respondents reported considerable growth in nominal sales since 1983.

Statistics Canada (1987b) recently reported data on 1985 capital expenditures, which included a breakout of spending that firms and government agencies categorized as being related to pollution abatement and control. The $91 million in pollution control machinery and equipment purchases reported across Canada appears to grossly understate the true volume of purchasing in this area, apparently because firms responding to the survey used an extremely narrow definition of pollution control spending or neglected to provide the required breakout.

In contrast to the Statistics Canada figure, the Department of Regional Industrial Expansion's (1987a) *Capital Investment Intentions Survey* reported that large companies (private and crown corporations, but excluding government departments) expected to spend $352.5 million in 1987 on pollution abatement investment in 1987. Expenditures in Ontario, based on the 1/3 share of all capital spending intentions attributable to Ontario, would be on the order of $120 million. However, Ontario firms may produce more than this figure, given the fact that Ontario accounts for about two-thirds of overall Canadian machinery manufacturing, according to the Ontario Ministry of Treasury and Economics (1986).

A study by the Department of Regional Industrial Expansion (1987) used unpublished data from Statistics Canada's Census of Manufacturers to identify 71 firms across Canada who reported the *production* of air purification and dust collection equipment or water, waste and sewage treatment equipment. These firms accounted for shipments of $140 million in 1984. This figure may well be consistent with MacLaren's estimate of $369 million in EP equipment purchases in 1979, since the MacLaren study included equipment that would lie outside the categories measured by DRIE and since the DRIE study measures domestic production (which could be lower than domestic sales given the high import share of the Canadian machinery and equipment market).

In its assessment of the competitiveness of the EP equipment sector, DRIE estimated the total size of the EP equipment industry (including instruments) across Canada in 1985 at $300 million, with 70% of the shipments, or $210 million, originating in Ontario. With annual growth of even 10% per year, this would put the Ontario industry at close to $250 million in 1987.

In addition to these equipment sales there are sales of materials, including filters, chemicals and other supplies. Chemicals used for water and wastewater treatment probably account for the largest share of these materials. Ropes and Lorenz (1986) reported that the supply of chemicals to U.S. water and wastewater treatment operations totalled some $2 billion (U.S.) in 1984. If, as one might expect, Ontario consumption is similar on a per capita basis, there would be on the order of $50 million in purchases of chemicals for water and wastewater treatment in Ontario. Production could be greater or less than this figure if Ontario has a trade surplus or deficit in chemicals.

On the basis of these data sources, and our own survey and interviews, we conservatively estimate sales of EP equipment, instruments and supplies manufactured in Ontario totalled roughly $200 - $400 million in 1987.

If we included all of the pipes, valves, screws, and other industrial equipment used in conjunction with specialized EP products, the total purchases of machinery and equipment used in environmental projects would be much greater and could run into the billions of dollars. However, the suppliers of these products are not in what we have defined as the EP industry.[1]

### 3.3.3 Recycling Services

Our fairly small sample of mail survey respondents sold close to $146 million in recycled products in 1987. The actual scope of recycling in Ontario is thought to be considerably greater than this figure. The Canadian Association of Recyclers estimates that the recycling and reclamation industry has annual sales of $1.5 - $2.0 billion (as cited in Canadian Recyclers Directory (1987)). Based on our survey results, discussions with industry participants, and the share of national economic activity that is likely to take place in Ontario, we estimate that the Ontario recycling industry accounts for annual sales of $0.5 to $1.0 billion.

### 3.3.4 Solid and Hazardous Waste Disposal and Destruction

Our mail survey respondents, which included several of the large waste haulers active in Ontario, identified revenues of close to $130 million in 1987. Interview respondents felt that this significantly underestimated the total volume of activity by the private sector, since there are a very large number of small firms involved in solid waste disposal. The Ontario Waste Management Association members employ some 3,000 to 5,000 workers, although the membership includes some firms that would be included in our recycling category. We have very roughly estimated the activity in this sector at $300-$400 million, based on our survey response and these other data.

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[1] The F.A.C.E. (1984) report estimated that the broad industrial output devoted to water and wastewater projects totalled $2.4 billion in 1984.

### 3.3.5 Construction Services

We did not include construction contractors in our survey, in part because it was difficult to identify which industrial contractors would be involved in EP projects, and in part because, as we note below official statistical data already provide a picture of the scale of much of this activity. Since the construction work purchased in Ontario is performed in Ontario, most of the value of such construction flows to Ontario based firms (or to local branches of national or international companies.) In 1987, Statistics Canada reported that a total of $404 million was spent on the construction of sewage systems, disposal plants and connections and water pumping and filtration plants in Ontario. This figure, however, includes the value of equipment installed, which would either be specialized equipment accounted for in our EP equipment estimate above, or general industrial products excluded from our industry definition. Based on the usual ratio of materials costs to the value of construction purchased[1], we estimate that the construction services provided, excluding equipment, totalled $250 - $300 million.

Additional construction work would be involved in major air pollution control and solid waste disposal projects. For example, according to an Ontario Hydro official, the installation of scrubbers at one generating station would involve labour costs (excluding engineering) totalling 86% of the specialized EP equipment to be installed. We estimate that an additional $100 - $200 million was associated with construction on these other EP projects.

In total, we estimate that $350 - $500 million in construction services was associated with the installation of EP equipment in 1987.

### 3.3.6 Consulting Engineering and Analytical Services

Our survey respondents reported 1987 revenues from consulting, engineering, analytical and other miscellaneous EP service of over $61 million, but there are a large number of consultants that were not included in this sample.

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[1] According to Statistics Canada (Construction in Canada 1985-87), the materials content of construction undertaken by utilities in 1987 was 30.1%. For all construction work, this ratio was 38%.

There are thought to be roughly 100 engineering consulting firms operating in EP areas in Ontario. According to the Association of Consulting Engineers of Canada (ACEC), there are 24 Ontario firms involved in the setting of environmental standards, 35 firms in air pollution control, 69 in water pollution control, 60 in solid waste disposal and treatment, 27 in toxic waste disposal, and 62 firms conducting environmental studies and impact assessments. Note that there is a considerable degree of overlap among the firms in various categories. Assuming our sample respondents were typical in size, the number of firms on the ACEC lists suggests total annual sales in excess of $100 million.

The Department of Regional Industrial Expansion (1987) estimated that consulting engineering fees in on environmental projects in 1987 would be on the order of $200-$400 million nationally. One would expect that Ontario firms would receive up to half of this total. Furthermore, analytical services are thought by industry participants to amount to a further $10 million in Ontario.

On this basis, we have estimated that consulting, engineering and analytical service firms (commercial laboratories) in the Ontario EP industry account for about $100 - $200 million in annual sales revenue.

### 3.3.7 Overall EP Industry Size

Summing up our estimates for EP goods and services, we conclude that the total size of the environmental protection industry in the province is on the order of $1.5 - $2.5 billion in terms of annual sales revenue, and excluding non-specialized goods and services used in conjunction with environmental protection products. Within these totals, water and wastewater treatment accounts for the largest share of the goods production sector, while the solid and hazardous waste disposal and recycling are the largest service sector contributors. In addition to these commercially provided goods and services, all three levels of government provide a range of environmental protection services.

### Table 2
### ESTIMATED 1987 REVENUES OF THE ONTARIO ENVIRONMENTAL PROTECTION SECTOR[1]

| **Commodity** | **Estimated 1987 Revenues** |
|---|---|
| Machinery, Equipment, Instruments, Supplies | $250 - $400 million |
| Recycling Services | $500 - $1,000 million |
| Waste Disposal and Destruction Services | $300 - $400 million |
| Construction Services | $350 - 500 million |
| Consulting Engineering and Analytical Services | $100 - $200 million |
| **TOTAL** | **$1.5 to $2.5 billion** |

1. Excludes services provided by directly governments

A number of other studies were examined to assess the validity of this overall size estimate. Ropes and Lorenz (1986) also estimates that the total market for water and wastewater treatment equipment, design and engineering, instruments and construction for industries, utilities and municipalities totalled close to $7 billion (U.S.) in 1987. Adjusting for the scale of the Ontario economy (GDP) relative to that of the United States, the provincial demand for water and wastewater goods and services would be on the order of $300 million, but this estimate appears low given the data available on construction that we have obtained.

As we outline below, U.S. data also provide useful indicators on environmental protection sector in Canada and Ontario. The American EP industry is somewhat more mature than that of Canada, and likely holds a greater share of its home market. However, if Ontario companies are able to capture a solid share of future environmental protection activity in the province the scale of the industry in the U.S. (relative to GDP) provides an indicator of the *potential* for the Ontario EP sector.

According to a study by Management Information Services Inc. (1986), approximately $70 billion (U.S.) was spent in the U.S. by private industry and all levels of government in 1985 on environmental control programs. A higher estimate (with a slightly different definition of expenditures) was produced by the Council on Environmental Quality, which projected annual expenditures in the U.S. on environmental protection at just under $93 billion (U.S.) (As cited in the MIS Inc. study noted above). If Ontario achieved the same level of expenditures as a share of GDP as these U.S. figures, there would be some $3-$4 billion spent annually on pollution control in the province. This estimate would include general industrial goods and services as well as specialized products. Our limited sample of survey responses, and our industry and purchaser interviews suggest that Ontario firms probably account for the majority of EP sales in the province.

Another estimate for the overall scale of Canadian EP *purchases*, as opposed to domestic production, was generated by Water and Pollution Control (1979). Using Statistics Canada and other government data on public sector spending, and data from private sector claims for accelerated capital cost allowances for EP equipment, they estimated that total annual capital spending in Canada on EP products was $1.5 billion per year over 1974-79. Their estimate used a very broad definition for EP spending, and included all expenditures on water and sewage treatment and distribution by municipalities. On the other hand, they believed that their methodology significantly underestimated private sector environmental spending.

Further estimates of the market demand or expenditures were obtained from our contacts in the course of our telephone interviews. Respondents estimated the Ontario demand for environmental protection, excluding construction, garbage hauling and municipal water and sewage treatment, at over $400 million per year. This also appears to fit reasonably well with our estimate of the broader industry size, which includes exports and sales to other provinces and the large municipal water, sewage and waste segment as well as construction.

### 3.3.8 Employment in the Ontario Environmental Protection Industry

The 159 firms that responded with employment data in our mail survey were responsible for the direct employment of 5,455 Ontarians (full-time equivalents) in their EP operations. The table below provides a breakdown of our survey results classified according to the firm's major EP product or service.

**Table 3:** ***Mail Survey Results***
**EMPLOYMENT IN EP ACTIVITIES**

| Primary Product/Service | # of Firms Responding | # of EP Employees |
|---|---|---|
| Air Quality Equip/Services | 37 | 1,119 |
| Water/Waste Water Treatment | 58 | 1,598 |
| Solid/Hazardous Waste | 64 | 2,738 |
| **Total** | **159** | **5,455** |

Total employment in the EP industry would of course be considerably higher than that indicated by our survey response. *Based on the ratio of employment to shipments indicated in our survey, the typical level of construction expenditures to construction industry employment, the ratio of employment to shipments of members of the Canadian Association of Recycling Industries, and our estimate for the total industry sales revenue, we estimate that the EP industry generates direct employment for 20,000 to 36,000 Ontarians.*

As indicated by the table below, this area of activity ranks environmental protection similarly to the communications equipment, clothing and wood products industries, and ahead of such industries as metal mining in terms of total Ontario employment. Even the 5,455 employees identified in our mail survey would put the EP sector close to or ahead of such industries as Shoe Factories (7,500 employees in June 1987), Knitting Mills (6,500) Iron Foundries (5,200), and Major Appliances (5,100).

**Table 4: EP INDUSTRY EMPLOYMENT IN ONTARIO RELATIVE TO SELECTED OTHER INDUSTRIES 1987**

| Industry | Ontario Employment |
|---|---|
| Rubber and Plastic Products | 48,100 |
| Paper and Allied Industries | 43,400 |
| Furniture and Fixtures | 34,800 |
| Communications Equipment | 30,000 |
| **Environmental Protection** | **28,000 (approx.)** |
| Clothing Industry | 27,400 |
| Wood Industries | 27,100 |
| Metal Mines | 19,700 |
| Pharmaceuticals and Medicines | 10,300 |

Source: Statistics Canada (72-002) data for June 1987, and Woods Gordon estimate

A much larger number of Ontarians are employed in all EP related activities, including for example, the employment of federal, provincial and municipal officials, environmental engineers at large industrial plants, and at firms manufacturing pipes, wires and other basic products used in conjunction with EP industry products. Glenn (1987) estimated that across Canada, the government sector employed over 50,000 individuals in environmentally-related positions, and in total (including non-specialized equipment producers), he estimated that Canadian EP employment was as much as 150,000.

### 3.4 Exports

Of the respondents to our mail survey reporting sales data, 66 firms indicated that some or all of their 1987 revenues were attributable to export sales. These firms registered total export sales of $67.8 million last year, or 13.5% of the total reported EP production in the province. It is not possible, however, to confirm whether or not this export share is typical for the industry, as most EP commodities are included in broader export figures in Statistics Canada data.

The large export figure in the solid waste services category is partly attributable to exports of recycled materials (scrap metal, etc.). Instrument manufacturers and consultants were the most active in terms of the share of their revenues attributable to such sales. The table below provides a breakdown of export sales classified by the primary sector of activity of the exporting firm.

**Table 5: EXPORT SALES BY PRIMARY COMMODITY PRODUCED**

| Commodity | Number of Firms Reporting Exports | 1987 Export Revenues |
|---|---|---|
| **Air Pollution Control** | | |
| Equipment and Instruments | 15 | $10,908,000 |
| Services | 5 | $1,005,000 |
| **Water and Wastewater Treatment** | | |
| Equipment, Instruments and Supplies | 19 | $12,861,000 |
| Services | 7 | $2,763,000 |
| **Solid, Hazardous Waste Disposal** | | |
| Equipment | 8 | $2,845,000 |
| Services | 12 | $37,426,818 |
| **TOTAL** | **66** | **$67,808,818** |

Several interview respondents also reported success in the export market. We highlight these findings in Chapter 5, where we discuss the competitiveness of the Ontario industry and the potential impact of free trade.

# CHAPTER 4
# GROWTH TRENDS AND PROSPECTS

## 4.1 Recent Trends

The table on the next page highlights the results of our mail survey findings on the growth rates experienced by firms in the EP sector over the 1983-87 period. The first two columns show the growth rates achieved by firms who reported sales in both 1983 and 1987. The second two columns report the growth rate in the total sales of all firms with sales reported for 1987. This rate includes the growth in total sales attributable to the entry of firms during the 1983 to 1987 period, although it may overstate the actual *industry* growth rate since it does not include firms that left the industry, and some firms may have failed to fully report sales in early years.

The results of our mail survey indicate that sales of industry participants have been growing quite strongly since 1983, particularly for firms in the air and water pollution control sectors. Those firms reporting EP sales in 1983 showed a compound annual growth rate ranging from 17% in solid and hazardous wastes to 32% in water and wastewater over 1983-87.

The compound annual growth rate of the sales of all firms in the sample has ranged from 19% in solid and hazardous wastes to 37% in water and wastewater over the period[1], although this may overstate the actual growth experienced by these firms since some firms may not have reported sales for 1983 despite actually generating revenues from EP products in that year. We believe that the data for firms with non-zero sales reported in 1983 is perhaps more closely representative of industry growth.

It should also be remembered, however, that 1983 saw the Ontario economy emerging from a recession, in which capital expenditures for all items had fallen off dramatically. Thus, the reported growth rates may exceed sustainable, longer term prospects. Solid waste hauling, which is less cyclical, probably showed less of a decline in the recession and which may explain the more modest 1983-87 growth rates reported.

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[1] This total growth rate is higher than that quoted in the preceding paragraph due to the inclusion of the 1987 sales of firms that did not report sales in 1983.

In addition, we suspect that the data may themselves overstate actual total industry growth over the 1983-87 period. Evidence from the growth of public expenditures on EP activities shows a somewhat more modest growth rate for their important share of EP spending.

**Table 6:** ***Mail Survey Results***
**GROWTH OF ENVIRONMENTAL PROTECTION SALES**
(Compound Annual Growth Rate 1983-87)

| | **Firms Reporting Non-zero Sales Revenue in 1983 and 1987** | | **All Firms Reporting Sales Data for 1987** | |
|---|---|---|---|---|
| | # of Firms | Annual Growth Rate | # of Firms | Annual Growth Rate |
| Air Pollution | 29 | 21% | 57 | 34% |
| Water and Wastewater | 43 | 32% | 72 | 37% |
| Solid/Haz. Waste | 40 | 17% | 83 | 19% |

## 4.2 Future Growth Prospects

### 4.2.1 Overall Growth

Both purchasers and suppliers of EP products and services anticipate rapid growth in sales over the next five years. The weighted average annual growth rate expected by the suppliers who responded to our mail survey for the next five years (with the weights based on each firm's share of total 1987 sales) was 17% per year, more than twice the growth rate generally anticipated for nominal GDP in Ontario. While this may reflect an overly-optimistic assessment by individual respondents on the share of the market their firm will achieve, it appears that there is a general consensus that environmental protection will be a very rapidly growing field as we move into the 1990's.

Most of the sales increase anticipated by EP suppliers is based upon their belief that environmental protection legislation will be significantly tightened in Ontario and elsewhere in Canada over the next few years. Purchasers generally appear to share this viewpoint. Indeed, virtually all market participants agreed that government policies will dictate the growth rate for EP activity, and that the Ministry of the Environment might therefore be in a better position than industry participants to assess future growth prospects.

Both suppliers and purchasers view the recent moves in Ontario to tougher legislation as being in part a response to similar legislation, if not always enforcement, in the United States. Ontario, in turn, is thought to be the path-breaking province for the rest of Canada. Ontario was viewed as being anywhere from 1-2 years to as much as five years behind the U.S. in some legislative areas.

There has also been a growing recognition that environmental protection that is engineered into the process through environmentally-sound basic design, rather than added as an end-of-pipe system., may improve efficiency and reduce production costs. This perspective still appears to be stronger among engineering and technical staff than among industrial managers, according to engineering staff contacted in the course of this study.

Export opportunities are also expected by industry participants to provide further room for growth in Ontario EP goods and services production. A report prepared for Environment Canada (1987) on *International Opportunities for Canada's Environmental Industries* concluded "that:

> 1. The environmental protection and conservation industry is extremely capable…;
>
> 2. International markets provide an extremely good opportunity to mobilize and focus this industry for domestic opportunities as well as export sales;
>
> 3. Market opportunities, although not strong, are obvious and relate mainly to the provision or rehabilitation of public health engineering facilities (water and sewage works, solid waste management), but there are indications that opportunities for conservation, reclamation, hazardous waste management and environmental assessment are now developing."

### 4.2.2 Air Pollution Control

Most purchasers of EP goods and services that we contacted believe that spending by their firm and industry on environmental protection, and air quality in particular, will continue to grow in the years ahead. This view is based on their belief that regulations will continue to be tightened in Ontario under the CAP program, with a trend towards requiring the use of the best available control technology. Some purchasers also suggested that compliance rates are higher in the air quality field than in other aspects of environmental protection, which in turn helps to generate demand for air pollution control and monitoring products.

In addition, a majority of large environmental spending projects are tied to a major capital spending project, such as the opening of a new production facility or utility project. Such capital spending has been lagging behind the general economic recovery in Ontario, but purchasers of EP equipment in some sectors (paper, metals) felt that capital spending could gain momentum if the economic recovery continues in 1988-89. In the absence of plant expansions or major regulatory changes, growth in annual expenditures on air pollution control tends to be more modest. Indeed, plant shutdowns free up used equipment; two of the firms contacted have purchased used equipment for air pollution control.

Some purchasers felt that a cyclical, economic slow-down could affect air quality spending, since they felt that the government would be more likely to delay requiring such expenditures in a weak market environment.

Equipment and service suppliers concurred with the view of purchasers that the air pollution control market would exhibit rapid growth over the next five years, primarily based on their expectation of a continued tightening of the regulatory environment. Many of the larger firms we interviewed expected annual revenue growth of 15% to 20% over this period, or 10% to 15% after inflation. Those respondents to our mail survey whose primary EP activities were in the air pollution field expected a (weighted) average growth in sales (weights are based on 1987 sales revenue) of 15.0% per year, or about 10.5% after inflation. Such growth would far exceed the roughly 3% real annual growth rate generally anticipated for the overall provincial economy over this period.

Equipment manufacturers identified a number of growth prospects. For example, there are currently three provinces and a number of U.S states which have implemented legislation making mandatory the use of continuous warning devices on underground storage tanks. One domestic manufacturer produces a system with 80 percent-plus Ontario content which continually monitors diesel, gas, and chemical emissions from tanks and which provides an advance warning so that measures may be taken to prevent leakage into the water table. Such legislation, which we understand Ontario is currently considering, would benefit this company.

The area of portable gas detection and monitoring equipment is also felt to be a growth area, and one in which the province has good manufacturing capability. Energy efficient air quality monitors, wherein an infrared sensor activates a fan when the measured $CO_2$ reaches certain levels, is another growth area with Ontario capability. Similar applications extend to the triggering of alarms and the isolating of problem areas in instances when air quality problems are detected.

Some respondents felt that growth areas are to a great extent determined by media exposure and public attention. In this sense, projecting demand for environmental products is less predictable than that for other industries. One firm's sales are largely dependent on media exposure and legislation dealing with chemical waste. The company's perception is that the Pacific Rim represents an area of strong growth for its product line. Taiwan, Korea, Hong Kong and Japan are all expected by this firm to spend considerable amounts on environmental and toxic clean-up during coming years.

Manufacturers of dust collectors and fans have seen strong growth in recent years in line with the active Ontario housing market. The resulting workload for industries associated with wood, furniture and lumber has meant increased activity for certain Ontario air pollution manufacturers. One respondent estimated the Ontario market for air control equipment in the woodworking industry to total $5 million annually.

One respondent estimated the total North American market for cartridge collectors to be $100 million, primarily as a more compact and cheaper replacement for baghouses. Such a shift appears to be underway within the fabric filtration areas of the air pollution industry. A rough ballpark estimate places Ontario's proportion of this to be 2 percent, or $2 million. Another industry participant suggested that even for basic products such as baghouses there may be considerable activity in developing new and improved fabrics. Similarly, certain Ontario companies are working toward improving the ducting aspects wherein compartmentalization in the ducting would allow maintenance and servicing to proceed without having to shut down the entire ventilation system.

Many of the air pollution companies with whom we spoke expect that increased public awareness regarding air quality issues will contribute to increased sales for several years. For example, one respondent felt that higher energy costs will continue to lead to increased sealing of buildings and indirectly to increased requirement for air quality improvements. Similarly, the anti-smoking lobby will have a similar effect.

The scrubber industry is expected to enjoy strong growth for many years, stemming from acid rain and the established 1994 emission targets. Recent Ontario Hydro projections of $3 billion worth of flue gas desulphurization (FGD) related expenditures, while noteworthy for their size, are nonetheless uncommitted and dependent upon the amount of coal capacity which the utility is forced to use as a result of energy demand trends, and the type of coal selected for use. Ontario Hydro's projections included retrofitting two 500 MW units in each of 1994, 1995, and 1996. Based on data reported by Ontario Hydro to Woods Gordon for the retrofitting of one Ontario Hydro generating station with FGD equipment, the FGD system itself would account for roughly one-quarter of the total scrubber installation cost.

There is a further trend in the air pollution industries away from in-house fabrication toward the contracting out of these basic, metal-fabricating aspects of the manufacturing process. One major manufacturer, for example, subcontracts work to five different contractors and therefore has lower overhead while receiving equivalent or better quality fabrication. This trend will encourage the growth of firms engaged in such subcontracting activities.

Most of the companies with whom we spoke indicated that, in a general sense, there will be an increasing trend toward process improvements rather than end-of-pipe applications. Some companies are already acting upon this trend by moving more toward the consulting and process evaluation functions rather than the strict manufacturing and marketing functions. An official at one such firm argued that 'the dirty work' - that is the hands on process improvement area - will provide strong growth for several years.

According to some suppliers, some of the past efforts at end-of-pipe designs have involved incorrect precipitator and other equipment application, such as the use of equipment that cannot adequately handle particle grain size and variance. In the area of scrubbers, there are often problems of inefficiency, winter-freeze and sludge disposal. In some cases these problems have been caused by an excessive orientation toward making a sale, that can lead to poor matches between what is required and what is actually installed. According to these equipment suppliers, increased attention to the process aspects would lead to the reuse of up to 25 percent of the sludge waste.

As in virtually any capital investment, many applications of air pollution control equipment are prone to undersizing. In these instances, the initial savings in capital costs inevitably catches up to the purchaser as higher maintenance costs. Such a tendency may be reflected in, for example, air to cloth dry filtration ratios which are too high for the application and therefore inefficient in the long-term but which at the same time are cheaper in the short-term.

### 4.2.3 Potable Water and Wastewater Treatment

Purchasers felt that tighter provincial regulations would promote the growth of the water pollution control market in Ontario. In the past, most of the spending has been tied to urbanization and population growth, as new water and wastewater facilities were installed to meet the needs of new residential developments. With the fall in population growth experienced over the last three decades and the expectation of continued moderate levels of population growth, there may now be a shift in the market towards repairing, replacing or upgrading existing systems, rather than new installations. This trend will be reinforced by the tightening of regulations expected to emerge from the current round of consultations under the Municipal Industrial Strategy for Abatement (MISA) program. Municipalities will be required to install the best available technology in their wastewater facilities. Until this requirement has been defined, municipal purchasers of wastewater treatment equipment feel that they are not in a position to assess the impact of MISA on their demand for environmental protection goods and services.

Respondents to our mail survey whose primary activities were in the water and wastewater field supported the overall view of purchasers that continued growth in this sector was likely over the next five years, with a weighted average projected growth rate of

18.1% per year (excluding one very high outlying estimate), or about 13.5% after inflation, well above the prevailing industrial growth rate in Ontario.

According to Ropes and Lorenz (1986), the U.S. experience suggests that the impact of legislation on expenditures is not necessarily an immediate one, as some polluters seek to delay expensive investments until forced to undertake them by enforcement measures. Industrial wastewater treatment demand is expected to lead to a 10% annual growth in the U.S. market for package wastewater treatment plants for industrial applications. Municipal expenditures are expected to be less buoyant, and dependent on improved funding from more senior levels of government and trends in the privatization of municipal facilities.

The industrial water treatment segment of the market makes more uses of chemical treatment or advanced treatments (ion exchange, electrodialysis, reverse osmosis) as a supplement to the sedimentation and biological processes used by municipalities. Some purchasers also noted that the demand for these more complex technologies will be stronger in Ontario than in parts of the United States, since some biological processes work less well in colder climates.

In addition to the demand for complex treatment technologies, according to the Federation of Canadian Municipalities, there is also a need for more investment in basic water and wastewater infrastructures. Many of the province's older municipalities are overdue for repairs and replacements of sewer pipes, water lines, and other basic elements of water systems. The growth in the supply of such products, and the related construction services, will depend on the success that municipalities have in seeking funding from more senior levels of government.

There are a number of wastewater and sewage projects currently underway across Ontario. For example, Ottawa is spending over $300 million during the next eight years for a sewage treatment facility; another new installation will be constructed in Oakville. In eastern Ontario, the peak in demand may have passed, as recent expansions have been completed during the past five years in each of Napanee, Brockville, Cornwall, Belleville, and Kingston.

While there are new installations in expanding subdivisions and northern communities, in the many populous regions the existing capacity is thought by municipalities to be sufficient to accommodate population growth for many years. Primary activity in the Ontario wastewater and sewage treatment will rest in the replacement and rehabilitation of existing equipment, although a major effort to clean-up the problems associated with sewage overflows into Lake Ontario could require significant expenditures on new equipment in the greater Toronto area.

The province of Quebec is currently in the midst of a major expenditure program directed toward the clean-up of wastewater and sewage. As of 1986, only 19.5 percent of the province's population was served by sewage treatment plants. In 1979, the provincial budget outlined a twelve-year program (1979-1991) committing $4 billion toward municipal wastewater and sewage treatment. The province has already spent the bulk of this amount, but industry participants feel the program may be extended with additional financing through 1994. Ontario firms report some difficulties in tapping into these government funded projects in Quebec without establishing manufacturing facilities in that province.

Groundwater cleanup was also cited by industry participants as a potential area for growth. One interview respondent hypothesized that Ontario's extensive surface water resources has led to a focus on keeping lakes and rivers clean, while ignoring the issue of groundwater pollution by industrial toxins and organic contaminants. A significant amount of work in this field was thought to have been done in the U.S. in this area, and Ontario was viewed as having to catch up to the level of activity south of the border. Ontario is seen to be supporting this effort through the establishment of a Centre of Excellence on groundwater research.

The water treatment chemicals market tends to be much more stable than other sectors, as annual expenses by water treatment plants on chemical supplies do not fluctuate with the overall economy.

The instrument market is thought to be a growth area, as the demands for monitoring and analysis increase with concerns over low levels of contaminants. Lorenz and Ropes (1986) cited this as an area where there was room for new entrants to the American market, particularly for on-line analyzers.

Canada has historically been quite active in infrastructure developments in lesser-developed countries, and Canadian water and wastewater treatment equipment manufacturers have on occasion benefitted as a result. Typically, foreign work involving the Canadian International Development Agency (CIDA) would place added importance on the issue of Canadian content when selecting suppliers.

### 4.2.4 Solid and Hazardous Waste

Solid waste disposal is a growing field in Ontario, as municipal and industrial waste volumes continue to expand. Among those surveyed, there was a strong consensus that some of the newly emerging areas of solid waste management will be among the fastest growing segments of the environmental protection industry, as restrictions on landfill sites force waste generators to turn to alternative methods of disposal for at least some of their waste materials. For the sector as a whole, which includes the more stable waste hauling industry, respondents to our mail survey anticipated a weighted average annual growth rate[1] of 16.3%, or about 12% after inflation.

Among these newer fields, biomedical and other hazardous waste handling are expected to grow quite rapidly. Hazardous waste incineration could be a future area of growth in serving the needs of the chemicals and metals industries.

In these and other industrial areas, tightening regulations and new concerns over even low concentrations of toxic substances are expected to lead to a significant growth for a number of hazardous waste treatment firms. A small Ontario firm has now started production of newly designed photochemical oxidation equipment to destroy persistent organic contaminants found in low concentrations in air, water and soil, as an alternative to incineration. This firm has found it beneficial to develop technology in anticipation of more stringent regulations, such as tighter controls over dioxins and other dilute contaminates in pulp effluent from bleaching plants. Another Ontario firm is also looking at biochemical means of toxic waste destruction.

Secure landfill sites, with proper geological properties to prevent groundwater contamination, are becoming increasingly scarce with more intensive use than expected. These sites are used for such wastes as contaminated soils, ash and heavy metals. According to a waste disposal industry official, one site initially expected to last five years is now projected to be filled after only two years after accepting about 300 tons per day.

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[1] Growth rates were weighted by the share of reported industry sales accounted for by each respondent.

The shortage of landfill sites and a reluctance of communities to accept new ones is projected by respondents to lead to a resurgence in interest in recycling, which will also generate new demand for specialized equipment designed to process waste materials. Several municipalities are now in the process of developing recycling programs for household wastes. Others, including the Peel region, are adopting or considering programs for industrial/commercial waste recycling. The development of biodegradable packaging is also seen to be an area for research.

Among oil refineries, heavy metal removal from the soil, and the monitoring of lead levels around petroleum product retail sites are areas that are thought by refinery engineers to be growing.

## 4.3 Conclusion

Our mail survey, and our interviews with selected industry participants, suggest that strong growth opportunities exist in all three major segments of the environmental protection industry (air, water, solid waste). Near term opportunities will include the supply of goods and services related to meeting the needs of such purchasers as Ontario Hydro and other responding to tightened provincial regulations. There are important requirements for monitoring equipment and analytical services, designed to meet the new emphasis on monitoring and controlling emissions of toxic substances in low concentrations. In the longer term, solutions to the growing problems associated with solid waste disposal could provide opportunities for recycling services and various process innovations designed to reduce waste production at the source.

# CHAPTER 5
# ONTARIO COMPETITIVENESS AND THE IMPACT OF FREE TRADE

## 5.1 Introduction

The future of the environmental protection industry in the province will depend on the ability of firms in Ontario to compete with import suppliers from the United States, Europe and the Far East. In the goods sector, Ontario firms already compete with imports, particularly in the fields of instrumentation and basic equipment (pumps, motors and other machinery) used in environmental protection. In the service sector, much of the activity in the province is handled by local employees, whether of Ontario or Canadian based firms or local branches of multinationals. In this chapter, we examine the relative competitiveness of Ontario goods and services producers in the environmental protection sector, and the potential impact of free trade on this sector.

Our results are necessarily somewhat general. The very wide range of activities undertaken as a part of environmental protection will mean that overall generalizations about the ability of firms in this sector to compete need not be applicable to all areas of specialized activity. However, our discussions with both purchasers and suppliers in this market have provided a useful overview on the ability of Ontario firms to thrive in a more liberalized trading environment.

For the purposes of this chapter, we have segmented firms into a slightly different group of categories than that used in other chapters. Equipment manufacturers for air, water and wastewater treatment, and solid and hazardous waste disposal are treated separately from both control, sampling and monitoring (CSM) equipment makers, and from environmental engineering and other service providers. These latter two categories encompass firms providing equipment and services in all areas of environmental protection.

On balance, our findings suggest that free trade will be modestly beneficial to the Ontario environmental protection industry, despite the fact that existing trade barriers are higher on U.S. exports to Canada than on Canadian exports to the United States. Freight costs and custom design will continue to limit the extent to which the final assembly of EP products could be centralized outside the province. Ontario service sector firms are quite competitive, and could expand the export of consulting engineering and design services. In the higher-technology areas, Ontario firms are competitive in certain product niches, while other goods are already largely imported.

There was a broad concern that exchange rates were at least as important as tariffs in determining Ontario's trade balance in the EP sector. Many respondents suggested that their competitive position would be eroded if the Canadian dollar went much above $0.80 U.S. in the absence of other competitive-enhancing developments, such as more moderate wage rate inflation in Canada than in the United States, or improvements in our relative labour productivity.

Some of the other factors affecting the Canadian EP trade balance will not be addressed by the Free-Trade Agreement. The lack of awareness among Canadian engineering consultants about Canadian supply capabilities, and the resulting frequency with which they direct business to foreign suppliers in their specifications, was mentioned by Canadian manufacturers of water treatment equipment (and other EP products) as being a trade irritant.

Another possible self-imposed barrier to exports results from the dominant role played by foreign-owned branch plants in Canada, who have not been given mandates from their parent companies for export operations. DRIE (1987b) estimated that 38 of the 50 largest EP manufacturers in Canada are foreign-owned, but believes that domestically-owned firms account for the lion's share of the Canadian EP exports. One multinational we contacted admitted that their Canadian branch does not actively seek export opportunities. This tendency is due to the fact that the branch plants were originally established to get around Canadian tariff barriers, with exports to other countries handled by the parent company's larger and generally more efficient production facilities.

### 5.2 Indirect Impacts of Free Trade

The environmental protection industry could be indirectly affected by free trade if the agreement affects the prospects for their industrial customers in the province. Some of the purchasers surveyed by Woods Gordon in late 1987 had not yet conducted detailed examinations of the implications of free trade for their sector. Chemical producers felt that Canadian production of chemicals could be increased by a the Free Trade Agreement, which in turn could generate some additional demand for environmental protection products. Similar views were expressed by some respondents in the pulp and paper industry, although the prevailing view appeared to be that free trade would serve to protect their existing access to the U.S. market rather than significantly expand it. Wood products firms did not foresee any major impact in either direction. Municipalities, utilities and the government are not likely to be strongly affected by the Agreement.

The existing literature on the impact of free trade on these and other Ontario industries using air pollution control equipment and other EP products and services also offers mixed conclusions. Lazar (1987) argues that, on balance, manufacturing activity in the province could be reduced by the Free Trade Agreement. Most of the literature, however, supports a conclusion that manufacturing output in Canada (and likely, in Ontario) will be enhanced by the improved access to the large U.S. market and the resulting scale economies that will be possible in Canadian plants.

The nature of the adjustments foreseen by these authors (see Cox and Harris (1984) for example), may suggest that the number of plants in Ontario could be reduced despite the overall increase in output, as industries rationalize production to achieve the necessary scale economies. This consolidation of production into fewer plants is a key element in the process of the increased competitiveness needed to expand manufacturing output in Canada. Such a process could act to reduce the demand for environmental protection goods and services, since two small plants will generally require more EP goods and services than one large plant with the same total output.

## 5.3 Air Pollution Control Equipment

### 5.3.1 Current Trade Pattern

Official statistical data on Canadian exports do not permit the identification of Canadian air pollution control equipment exports. Firms in our mail survey who were primarily in the air pollution control equipment and instrument industry reported exports (for all EP goods and services they produce) of $10.9 million for 1987.

Some of the imports in this area are classified under "Ventilating and Dust Collecting Equipment" by Statistics Canada. Table 7 summarizes the recent trends in this area. While the dollar values of imports are not large, they are significant relative to the size of production in Ontario, although part of this category represents equipment that is not used in air pollution control.

Table 7
IMPORTS OF VENTILATING AND DUST COLLECTING EQUIPMENT
(Millions of Dollars)

| | Imports into Canada | | | Imports into Ontario (est.) | | |
|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1984 | 1985 | 1986 |
| Imports from U.S. | $12 | $15 | $13 | $9 | $11 | $10 |
| Total Imports | $14 | $18 | $19 | $10 | $13 | $14 |

Source: Department of Regional Industrial Expansion (1987b). (DRIE made the estimates of imports into Ontario, based on their understanding of Ontario's share of total purchasing.)

### 5.3.2 Current Trade Barriers

Most U.S. air pollution control equipment imports into Canada face a 9.2% tariff, while Canadian exports to the U.S. of such equipment face a tariff in the 3-6% range, mostly at 3.9%. $2 million of the $13 million in 1986 ventilation and dust collection equipment imports into Canada were exempted from duties under the Machinery Program, which permits the duty free import of machinery and equipment not available from Canadian manufacturers.[1] Aside from tariffs, the other major trade barriers facing Ontario firms in this industry are preferential purchasing programs of public utilities under "Buy America" programs.

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[1] Items qualifying for duty-free entry into Canada under the Machinery Program are listed in Memorandum D8-5-1 of March 11, 1987 published by the Department of National Revenue, Customs and Excise.

Table 8
TARIFFS ON SELECTED AIR POLLUTION CONTROL PRODUCTS

| Commodity | 1988 Tariff | Years to Duty-Free Status Under FTA |
|---|---|---|
| **Canadian Exports to the U.S.** | | |
| Filtering or purifying machinery and apparatus for gases and associated parts (excl. intake filters for internal combustion engines) | 3.9% | 0 |
| Centrifuges and parts | 3.9% | 3 |
| Large fans, vacuum pumps and parts | 4.7% | 3 |
| **U.S. Exports to Canada** | | |
| Filtering or purifying machinery and apparatus for gases and associated parts (excl. intake filters for internal combustion engines and equip used in metal/mineral refining/smelting) | 9.2% | 0 |
| Centrifuges and parts | 9.2% | 3 |
| Large fans, vacuum pumps and parts | 9.2% | 3 |

Source: Canada-U.S. Free Trade Agreement, appendixes.

The major non-tariff barrier in air pollution control equipment is the extensive metal fabrication component of much of the final products sold in this category. This metal fabrication is often conducted on site. Thus, even for imported products, there is a need for a considerable portion of local value-added. Freight costs also favour local purchasing of low-value metal parts.

### 5.3.3 Competitiveness of the Ontario Air Pollution Control Industry

The air pollution control industry is highly globalized. Multinational companies, based in the U.S., Europe, and Japan, appear to be the source of much of the specialized equipment presently in use for air quality control. Purchasers do not tend to be highly informed on the location of production for equipment purchased from Ontario suppliers.

For those respondents who could identify product sources, domestically-owned, Ontario firms appear to play a larger role in the supply of services for air quality control rather than in the production of equipment. In the equipment field, Canadian-assembled products, with some import content, appear to make up the majority of items purchased. Ontario content in major capital spending projects is enhanced by the need for on-site metalwork and assembly.

In the higher volume items, the movement away from more basic systems to higher technology devices may hurt Ontario suppliers, who are characterized (by purchasers) as suppliers either of more basic equipment, or very specialized, low volume items. In filters, for example, High Efficiency Particle Air (HEPA) filters are expected to be a growing market, but they tend to be imported.

Some respondents felt that presently available technologies leave a number of unmet needs, and thought that this situation indicates that there is room in the market for an innovative Ontario firm to develop new products and processes, and thereby capture more of the equipment market. In particular, one consulting engineer felt that the existing systems for dealing with the problems of acid precipitation and hazardous substances were not fully meeting the demands from industrial emittors. The largest emittors are still in the process of determining how they will meet the government's targets for acid rain control by 1994. Solid waste incinerators built in the future will be required to install baghouses, scrubbers and other control devices, rather than merely relying on a high stack to disperse emissions.

Based on our limited sample, it appears that there may be a tendency for foreign-based multinationals to make fewer of their air quality purchases from Canadian/Ontario suppliers, relative to the purchasing patterns of domestically-based companies, or to prefer locally assembled versions of imported technologies. One respondent from a consulting firm suggested that these branch plants may be duplicating process and equipment decisions made by their parent companies. Most firms, however, claim that they will use an Ontario supplier if one is available and price-competitive, and where construction is involved, the work is usually-undertaken by Ontario-based firms.

Better service is usually cited as a reason for dealing locally, although foreign equipment can be accompanied by the same level of service through a local dealership.

The air pollution control equipment industry is an industry which involves extensive fabrication of metal. As such, the Ontario content is traditionally very high - in excess of 85 percent - for most types of air pollution control equipment. The industry is quite competitive, wage rates are comparable to those of the northern states, and the small size and flexibility of many of the companies allows them to successfully pursue certain targeted segments of the market.

In the dust collection, fans, and precipitator industries, Ontario companies generally compete against other Ontario companies rather than imports. For example, a major manufacturer of dust collectors, fans, precipitators and other air pollution control equipment generally sells equipment with 100 percent Ontario content. A few components such as solenoid valves may be imported due to lack of local availability. Another firm produces electronic air cleaners, which are substitutes for precipitators, again with close to 100 percent Ontario content.

Given the labour content, basic technology and fabrication orientation of most air pollution industries, price is generally the top competitive issue, with the lowest bid inevitably winning the job.

In the cartridge collector industry, Ontario has a strong presence and 95-98 percent Ontario content is generally attained. This is a method of filtration involving long cylindrical bags and felt to be a compact and less costly alternative to conventional baghouses.

According to engineering officials with Ontario Hydro, the Ontario content of the proposed expenditures on scrubbers is quite high. Although certain components of the flue gas desuphurization (FGD) system may be imported from the U.S., the overall Ontario content of one sample FGD project would be over 90 percent.

### 5.3.4 Anticipated Impact of Free Trade

Most of those companies with whom we spoke felt that free trade would have a marginally positive effect on the profitability of their Ontario operations. In many of the environmental industries, the removal of 4-6 percent tariffs into the U.S, combined with the psychological aspects of freer trade, is felt to be a positive development.

This majority view is shared by the federal Department of Regional Industrial Expansion, which forecasted a positive net impact of free trade on this sector in its impact assessment for the Trade Negotiations Office. DRIE's view is that the standardized nature of most of the technology involved in air pollution control, and competitive manufacturing costs in Canada, will ensure that the Canadian industry will thrive in a liberalized trading environment.

Contradicting this, however, is the opinion of certain of our contacts that U.S procurement will always favour domestic suppliers, that Americans generally tend to 'wave the flag' more in this respect, and that this will remain unaltered by any trade agreement. Others felt that the agreement would not have much effect in either direction, since the current tariff levels into the U.S. are not a major impediment.

In a situation where the Ontario company has a U.S affiliate and an agreement between the respective divisions, the trade agreement may tend to cause change in such arrangements. In the arrangement which one major equipment manufacturer maintains, for example, the Canadian operation may gain access to serving the northeastern states - an area which is currently poorly served by the west-coast plant of its U.S affiliate. Another wholly-owned subsidiary of a large American-based multinational has gained a mandate to serve certain North American segments of the cartridge collector market and thus will be more competitive under the trade agreement than would otherwise have been the case.

The reduction in the arbitrary use of trade laws that is expected to result from the trade agreement was mentioned as beneficial by many of our respondents. One particular example cited was that of a 25 percent tariff on one of its products which was applied 'on a whim' a few years ago. Others felt that in general, a more certain trading environment would increase the incentives for Ontario manufacturers to develop markets in the United States for their products.

## 5.4 Water and Wastewater Treatment Equipment

### 5.4.1 Current Trade Pattern

Like the air pollution control sector, the water and wastewater treatment equipment sector is labour intensive and involves significant local fabrication. Ontario content for most water and wastewater treatment installations is close to 90 percent, as a result of the extensive construction requirements.

On balance, although the data are not complete, the Department of Regional Industrial Expansion believes that Ontario runs a small annual surplus on trade with the United States in the potable and wastewater equipment market. Exports from Canada and Ontario of water and wastewater treatment equipment are incorporated into broader categories by Statistics Canada, although they are generally included in the commodity category "safety and sanitation equipment". Canadian exports under this classification were $117 million in 1986, of which $98 million were destined for the American market. Mail survey respondents whose primary EP area was in the water and waste water goods (including instruments and supplies) sector reported exports of $12.8 million in 1987.

Most of the imports into Canada are included in the commodity category "water and sewage treatment equipment". Figures for imports in this category are provided in Table 9 below. Imports are also in part incorporated into the category "industrial filtration machinery and filters", which totalled $38 million in 1986. This category also captures elements of the air pollution control equipment market.

### Table 9
### IMPORTS OF WATER AND SEWAGE TREATMENT EQUIPMENT
(Millions of Dollars)

| | Imports into Canada | | | Imports into Ontario (est.) | | |
|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1986 | 1984 | 1985 | 1986 |
| Imports from U.S. | $36 | $44 | $44 | $23 | $29 | $29 |
| Total Imports | $41 | $47 | $52 | $27 | $31 | $34 |

Source: Department of Regional Industrial Expansion

### 5.4.2 Current Trade Barriers

The tariff on potable and wastewater equipment imported into Canada is 9.2%. An exemption applies on equipment imported under the Machinery Program, which allows for the duty-free importation of machinery and equipment not available from Canadian production. Of the $44 million in water and sewage treatment equipment imported into Canada in 1986 from the U.S., $11 million was eligible for duty-free status under this program. Similarly, $3 million of the $30 million in industrial filtration equipment and filters imports from the U.S. were exempted from duties.

Canadian water and wastewater treatment products face a 3% to 6% tariff when exported to the United States. The major trade impediments, however, are non-tariff barriers that result from the high-percentage of public sector purchases in the water and wastewater treatment field. For example, the Small Business Set-Asides program in the United States requires that, on those American projects receiving public financing, 20% of the contract value must be directed towards small American businesses. The Free Trade Agreement (in Annex 1304.3) specifically excludes Canadian access to contracts set aside on behalf of small or minority-owned American businesses.

In addition, Buy America legislation also requires that projects receiving federal financing must provide a price preference for domestic suppliers over foreign bidders. This legislation has been particularly relevant for the water and wastewater treatment sector, since virtually all of the municipal and many of the industrial water treatment projects are granted such public financing.

### Table 10
### TARIFFS ON SELECTED WATER AND WASTEWATER TREATMENT EQUIPMENT

| Commodity | 1988 Tariff | Years to Duty-Free Status Under FTA |
|---|---|---|
| **Canadian Exports to the U.S.** | | |
| Filtering or purifying machinery and apparatus for water and associated parts | 3.9% | 3 |
| Pumps (with some exceptions) | 3.0% | 3 |
| Large iron/steel tanks | 2.6% | 10 |
| **U.S. Exports to Canada** | | |
| Filtering or purifying machinery and apparatus for water and associated parts | 9.2% | 3 |
| Pumps (with some exceptions) | 9.3% | 3 |
| Large iron/steel tanks | 7.8% | 10 |

Source: Canada-U.S. Free Trade Agreement, appendixes.

The U.S. Environmental Protection Agency administers these Buy America programs for water and wastewater projects. They typically have the effect of awarding contracts to U.S. bidders (with American content in excess of 50%) over imported products where the American price is up to 6% above that of the import supplier. One leading Ontario manufacturer expressed the view that these provisions have the effect of shutting out Canadian exporters from a significant slice of the U.S. market, and that many Canadian firms have not bothered to bid on projects where they know that domestic or local purchasing preferences are likely to apply.

The Free Trade Agreement only directly addresses the purchases made by the U.S. federal government and its agencies. The government procurement chapter of the agreement will extend the equal access provided by GATT on purchases over $171,000

(U.S.) to all purchases over $25,000 (U.S.). This would not appear to challenge the domestic and local purchasing preferences of state and local governments, or federally-funded private-sector organizations.

### 5.4.3 Competitiveness of the Ontario Water/Wastewater Treatment Industry

Many of the domestically-owned companies operating in Ontario are small, niche-oriented companies where flexibility and quick response times are critical requirements. These firms are often technologically driven (i.e., they have emerged or grown as a result of successful R&D efforts), entrepreneurial firms that anticipate or react quickly to legislative change.

Some of the larger companies that provide basic equipment and chemicals are Canadian branches of international firms. Most standard sewage and water treatment equipment has been available for decades, and thus the technologies are well-known. The major multinationals appear to conduct little R&D in Ontario as a result, and the research that is necessary is generally conducted in their home countries. Production in their Ontario plants is usually focussed on manufacturing and sub-assembly for the Canadian market, with instruments and other components being imported from the U.S. or overseas.

Firms operating in this sector in Ontario feel that they are quite competitive on costs with suppliers outside the province at current exchange rates.

Clarifiers, sludge collectors, filter presses, bar screens, and other types of equipment are widely available from Ontario suppliers. Chemicals for use in water treatment facilities are available from Ontario production. The Kingston water treatment plant, for example, sources chlorine from CIL in Cornwall, and ferric chloride from Eaglebrook, an Ontario company. A leading petroleum refiner reported that it sources less than 25% of its wastewater treatment equipment requirements from outside the province.

There are certain other water and wastewater treatment products, such as rotating biological contactors and certain drive units, aerators and anaerobic treatment equipment, which are imported from the U.S., since the Canadian market is too small to support such firms. Gravity-belt filter presses for slurries and bio-sludges are imported from West Germany, the U.K. and the U.S., and patent protection prevents Ontario manufacturers from producing similar products. Specialized pumps tend to be imported from Europe, although a considerable amount of value-added in servicing these pumps is handled by local branches of pump manufacturers.

One firm we contacted is a highly competitive Ontario manufacturer of chemical metering pumps directed toward any industry using chemicals in its process. They achieve an Ontario content of up to 80% depending on the type of pump and the amount of local machining. The local availability of spare parts is a significant, though decreasing competitive advantage for this firm.

The clean-up of petroleum-related spills involves a range of equipment and materials including oil booms, pumps, and absorbents. Sorbants are materials that absorb oil and petroleum base wastes without absorbing water. They are lightweight materials, easily shipped, and some are imported. Some skimmers and booms are also imported.

### 5.4.4 Impact of Free Trade

Ontario manufacturers of water and wastewater treatment equipment contacted by Woods Gordon were divided on whether or not free trade would be beneficial to their operations in the province. Many firms appeared to be uncertain as to how the agreement will ultimately affect their operations. Among those who expressed a viewpoint, the overall balance of opinion was somewhat in favour of the agreement.

In particular, companies that have already carved a niche in the U.S market appear to be the most receptive to reduced trade barriers. For example, one company who was in the process of shipping venturi tubes to Rhode Island felt that the trade agreement would help to reduce the 'buy local' pressures which exist in Pennsylvania and other states. The same company however cautioned that a Canadian dollar in the range of $0.80 (U.S.) was necessary to remain competitive.

Among the foreign owned subsidiaries where the product line of the parent company is being represented in Canada, a minority expressed the view that free trade may incite the domestic manufacturers to "eliminate some equipment manufacturing here if it can be brought in cheaper from the parent". Another subsidiary felt that the maintenance of separate administrative personnel in Canada could be affected by free trade, and that the maintenance of a plant of only 25 people would also be brought into question by the parent executives. Other heavy equipment manufacturers felt that freight costs and favourable

Canadian wage rates relative to the Northern U.S. would permit continued local manufacturing for the Ontario and Canadian market under free trade, although there was a broadly-based concern that exchange rates must remain favourable for Ontario manufacturing to be viable.

Our findings concur with those of the the Department of Regional Industrial Expansion, which has also interviewed firms in this industry, and argued in its Trade Impact Assessment that free trade would be a positive development for Canadian water and wastewater treatment manufacturers on balance.

## 5.5 Solid and Hazardous Waste Equipment

### 5.5.1 Current Trade Pattern

Canadian exports of solid and hazardous waste equipment are not segmented in official trade data, but are estimated by DRIE at $10 million for 1986, of which Ontario is thought to account for about $7 million. Our mail survey respondents, in a broader category which included instruments and supplies, reported exports of $30 million, although some of these firms may be exporting other EP products and these exports would be included in our total.

Imports under the category "garbage disposal units" were $8 million in 1986, of which close to $6 million were into Ontario. The federal industry department believes that Ontario runs a slight surplus in overall trade in this area with the United States.

### 5.5.2 Current Trade Barriers

Local purchasing preferences by municipal waste disposal agencies were cited by industry participants as one of the more important non-tariff barriers in this area. As we have already noted, only federal level purchasing procedures were explicitly addressed in the Free Trade Agreement, although further discussions on procurement policies will take place if the treaty is approved. Equipment manufacturers in the hazardous waste industry also expressed concerns over the lack of bilateral acceptability of test data. The duplication of testing and application for approval from the U.S. Environmental Protection Agency (EPA) and the Canadian provincial authorities imposes a costly burden on producers competing outside their home market.

**Table 11: TARIFFS ON SELECTED SOLID AND HAZARDOUS WASTE DISPOSAL EQUIPMENT**

| Commodity | 1988 Tariff | Years to Duty-Free Status Under FTA |
|---|---|---|
| **Canadian Exports to the U.S.** | | |
| Sorting, screening, separating, washing crushing, grinding, mixing machinery and associated parts | 2.9% | 3 |
| Tankers and other trailers | 3.1% | 10 |
| Trucks fitted with lifting/handling equipment, self-propelled, non-electric (excl. LPG powered fork lifts for factories) | 0.0% | 0 |
| Conveyers | 2.0% | 3 |
| Bulldozers, mechanical shovels compactors, etc. | 2.5% | 3 |
| Electric Furnaces (for PCB destruction) | 2.5% | 3 |
| Iron/Steel Containers | 0.0% to 5.0% | 10 |
| **U.S. Exports to Canada** | | |
| Sorting, screening, separating, washing crushing, grinding, mixing machinery and associated parts | 9.2% | 3 |
| Tankers and other trailers | 15.0% | 10 |
| Trucks fitted with lifting/handling equipment, self-propelled, non-electric (excl. LPG powered fork lifts for factories) | 9.3% | 3 |
| Conveyers | 9.2% | 3 |
| Bulldozers, mechanical shovels compactors, etc. | 9.2% | 3 |
| Electric Furnaces (for PCB destruction) | 11.2% | 3 |
| Iron/Steel Containers | 7.8% to 10.6% | 10 |

Source: Canada-U.S. Free Trade Agreement, appendixes.

### 5.5.3 Competitiveness of the Ontario Industry

Ontario has a strong capability in the solid and hazardous waste industries. In the area of containers, Ontario firms are competitive manufacturers of fibre drums for incineration of hospital waste and steel drums to hold hazardous liquid waste and to prevent spills. Freight costs make international trade in this area virtually non-existent.

There is significant Ontario capability in the manufacturing of garbage trucks, with companies such as Jaeger, Frink, Demster, Sanitech, Amertek and Capital Disposal being mentioned by survey respondents as being prominent in the industry. Estimated annual production of garbage trucks in Ontario is 200 vehicles worth $20 million. Ontario content for rear loader garbage packers and recycle material pick-up vehicles ranges from 50-90 percent depending on the company and type of truck. The trend in the manufacturing area, like that in the service area, is toward recycling trucks as opposed to conventional rear loader refuse trucks.

Capability for the destruction of PCB's and other highly toxic wastes has been developed in Ontario, though one such technology was subsequently purchased by Westinghouse in the U.S. and its development was shifted to their American offices. A recent tender let by the MOE for PCB destruction in Smithville was believed (by an industry participant) to have received all American bids, which could indicate a weakness in the Ontario capability in this high growth area, although Ontario Hydro has used local firms. Recent findings by researchers funded by the National Research Council appears to show some promise for new approaches for the safe treatment and disposal of PCB's.

While expertise on hazardous wastes currently rests in the U.S, it is likely that the establishment of firm guidelines by MOE, combined with an emphasis on achieving high local content, would lead to the rapid development of an Ontario based industry. Currently, for example, one Niagara Falls firm has the expertise to manufacture plasma arc furnaces capable of achieving the temperature and resident time necessary to burn and break up organic chemicals. There are also indications of strong future demand for such expertise in the future; an industry participant estimated that there are 100 major hazardous waste sites in the Great Lakes basin, of which at least 10 are in Ontario.

### 5.5.4 Impact of Free Trade

As in other areas, the tariff barriers into Canada in solid and hazardous waste equipment are much higher than those facing Ontario exports in the United States. The federal industry department believes that free trade will nevertheless be beneficial to Ontario manufacturers in this industry, based on their ability to manufacture at competitive costs.

Our interview respondents generally felt that free trade would not have a significant impact in this area. This was disputed by one manufacturer of garbage trucks, who felt that the current tariff was needed and that U.S companies would swamp the Canadian companies under free trade. Given the scale economies that are generally achievable in manufacturing heavy machinery, there may well be some significant adjustments required by smaller Ontario manufacturers that have historically been geared for the domestic market.

## 5.6 Control, Sampling and Monitoring Equipment

### 5.6.1 Current Trade Pattern

As we have noted, Canada runs a significant trade deficit with the U.S. and other countries in control, sampling and monitoring (CSM) equipment used in environmental protection. Even where production is taking place in Ontario, many of the components used are imported from the U.S., Europe or the Far East. Table 12 captures the trade flows for selected types of CSM equipment.

Table 12
1986 CANADA-U.S. TRADE IN SELECTED CSM EQUIPMENT
(Millions of Canadian Dollars)

| Commodity | Canadian Exports to the U.S. | Canadian Imports from the U.S. |
|---|---|---|
| Industrial Control Equipment | $10 | $122 |
| Electrical Measuring/Testing Instr. | 23 | 134 |
| Physical Properties Testing Equip. | 10 | 96 |
| Thermal Measuring/Control Equip. | 1 | 12 |

Source: DRIE (1987b)

### 5.6.2 Current Trade Barriers

Similar to other areas of the EP sector, tariffs on Ontario exports to the U.S. are generally lower than those facing U.S. exports to Canada, although there are exceptions. Effective duties into Canada tend to be lower than those indicated, due to special exemptions on products not available from Canadian sources. Most of the duties in this area will be phased out over 10 years under the Free Trade Agreement, leaving some time for adjustments to take place.

## Table 13
## TARIFFS ON SELECTED CONTROL, SAMPLING AND MONITORING EQUIPMENT AND INSTRUMENTS

| Commodity | 1988 Tariff | Years to Duty-Free Status Under FTA |
|---|---|---|
| **Canadian Exports to the U.S.** | | |
| Electrical meters for liquid flows or levels | 4.9% | 10 |
| Electrical gas or smoke analysis apparatus | 4.9% | 10 |
| Optical gas or smoke analysis apparatus | 10.0% | 10 |
| Chromatographs, electrophoresis instr., spectrometers, spectrophotometers etc. (electrical) | 4.9% | 10 |
| Thermographs, hygrographs and other recording instr. | 3.0% | 10 |
| Automatic regulating and controlling instruments | 3.1% to 4.9% | 10 |
| **U.S. Exports to Canada** | | |
| Electrical meters for liquid flows or levels | 10.3% | 10 |
| Electrical gas or smoke analysis apparatus | 0.0% | 0 |
| Optical gas or smoke analysis apparatus | 7.5% | 10 |
| Chromatographs, electrophoresis instr., spectrometers, spectrophotometers etc. (electrical) | 0.0% or 10.0% | 10 |
| Automatic regulating and controlling instruments | 9.0% to 10.0% | 10 |

Source: Canada-U.S. Free Trade Agreement, appendixes.

Ontario firms in this area also mentioned government procurement preferences, and the difficulties, time and costs faced in attempting to "find one's way around" the complex regulatory corridors of the EPA, the Food and Drug Administration and other U.S. agencies, as non-tariff barriers to trade. Canadian firms have found that U.S. companies have more lobbying contacts and resources to spend in winning contracts with these agencies; one prominent firm has formed a joint venture with a U.S. firm to assist in marketing its product to American government agencies.

### 5.6.3 Competitiveness of the Ontario Industry

Based on our discussions with industry participants, it appears that less than 10% of the Ontario private and public sector demand for CSM equipment and instruments is met by Ontario manufacturers, although much of it is sold through local distributors. Very little in the way of process control equipment, pressure and temperature monitoring devices, and data acquisition and control devices is manufactured in the province.

In these instrumentation areas, where transport costs tend to be quite low relative to the value of the product, the small size of the Canadian market represents a very real problem for Ontario manufacturers. Competitors from the U.S and other nations are generally larger and have greater resources to devote toward product development and marketing. Furthermore, in those areas where Ontario is competitive, a feeling of domestic inferiority often works against the likelihood of native companies winning the contract. More than one respondent suggested that, quite simply, there are many monitoring, sampling and testing equipment areas where domestic demand will not justify the development of native expertise.

We understand that there are exceptions, and that some Ontario suppliers have successfully established themselves in the export market as well. Ontario manufacturing appears to be focussed on the production of small numbers of very high-priced, high technology units (trace atmospheric gas analyzers etc.) rather than on more general monitoring and testing equipment for which mass production offers scale economies. These latter types of equipment are available from some Ontario suppliers, but purchasers suggested that imported goods are offered at more competitive prices.

In the higher volume items, the movement away from more basic systems to higher technology devices may hurt Ontario suppliers, who are characterized (by purchasers) as suppliers of more basic high-volume equipment. Continuous emission monitoring (CEM) equipment, which tends to be quite expensive (close to $100,000 per system), would likely be imported, according to purchasers we contacted. Consulting engineers expect that the CEM field will be among the fastest growing segments of the air pollution equipment industry, as tightened enforcement generates the need for data.

One Ontario manufacturer of air and gas quality electronic sensors competes successfully against U.S, Japanese and European companies. This company maintains an ongoing R&D department and it directs its products toward the oil, paper, refrigeration, building maintenance and other industries concerned with air and gas quality. This particular company's product has an 80% Ontario content; in other instrumentation products made in Ontario, a significant proportion of the components (in some cases, nearly 100% of them) are imported .

Another Ontario manufacturer of instrumentation achieves close to 100 percent Ontario content. The company competes successfully in the U.S market and devotes a great deal of effort to that market. Domestically, the company feels that on certain occasions it has lost sales to U.S, British and German competition because of reverse discrimination resulting from the feeling of Canadian inferiority. It feels that wage rates are comparable between Ontario and U.S labour, with Ontario perhaps enjoying a slight advantage.

In the area of sampling, analyzing, and control instruments for water and wastewater treatment, the small size and more technological nature of the products relative to water pollution control equipment places added importance on scale and market factors. The companies in Ontario that competitively produce instrumentation generally have found a technological niche and are enjoying success in both Ontario and the U.S. For the most part, however, the limited size of the Ontario and Canadian market works against the development of a significant instrumentation industry in the water and wastewater field.

Foreign firms with operations in Canada generate some Canadian content through local services and occasionally assembly. For example, according to DRIE, atomic absorption spectrometers which measure trace levels of mercury are supplied in Ontario by Varian (an Australian company) with 40% Canadian content, by Perk and Elmer (U.S.) with 60% Canadian content, by Ingram and Bell (Japan) with 70% Canadian content and by Hadley Tekscience (U.S.) with 70% Canadian content. Note that at least one-half of these local content values are typically generated simply from taxes, labour, overhead and profit, rather than from purchases of local raw materials or parts, and thus the import content of subcomponents may still be quite high.

### 5.6.4 Impact of Free Trade

Suppliers in this industry generally felt that free trade would not have much of an impact on their Ontario operations. Canadian firms believe themselves to be quite competitive in the selective niches in which they now operate, and their access to the U.S. market will not be dramatically improved by tariff reductions, although they may be able to gain some market share at the expense of European competitors who will continue to face tariffs on their U.S. sales. The harmonization of product standards could also enhance the two-way flow of trade in instruments.

One firm also felt that its share of the U.S. public sector market might be enhanced by the agreement. Another noted the possibility of reduced Canadian production costs by being able to import parts duty free, although they would lose duty remissions on parts imports from Europe and the Far East on their exports to the United States.

One innovative instrument manufacturer describes the Free Trade Agreement as a "double-edged sword" offering both benefits and challenges, with a net positive benefit from their perspective. Its products face average tariffs of 6 percent and these will be eliminated under free trade. Furthermore the company uses a subsidiary in order to reduce the amount of the purchase price to which the duty is applied. The costs and paperwork associated with this process would also be eliminated under free trade.

## 5.7 Consulting, Engineering, and Waste Management Services

### 5.7.1 Current Trade Pattern and Competitive Position

We were unable to identify any useful data on trade in environmental services. In consulting and engineering services, Ontario firms are thought to have a very strong competitive position internationally, although American immigration procedures pose a barrier to the export of such services to the United States. Most firms were confident that Ontario would have a trade surplus with the rest of the world in this sector, and some felt that a trade surplus existed in Ontario-U.S. trade as well. Our mail survey identified over $60 million in annual exports by EP service sector firms, excluding sales of recycled products.

For the most part, the trade barriers discussed in the next section have meant that Ontario firms have established American offices, staffed largely by U.S. residents, to serve the American market. Similarly, U.S. EP service firms have set up operations in Ontario, employing Canadian workers.

Canadian engineering firms appear to enjoy somewhat more success in the U.S. market than do American firms in Canada. As a rough indication of this success, the Association of Consulting Engineers of Canada directory lists 32 Canadian firms with U.S. offices, while indicating only 2 American firms with Canadian offices, although neither list may be fully comprehensive.

In the hauling of solid and hazardous waste, both Canadian and American firms are active with branch operations in the other country. In the Ontario market, Laidlaw and Wasteco are prominent domestic firms while Browning Ferris and Waste Management are prominent U.S-based competitors. These firms typically have operations in many cities and they haul solid waste, toxic waste or all types of waste.

### 5.7.2 Current Trade Barriers

The most important trade barrier in this sector relates to the difficulties professionals face in crossing the border for work purposes. Employees of engineering consulting firms or service companies seeking to work in the United States are required to have temporary work permits or green cards. The inconvenience, time and delays involved in obtaining such documents have resulted in the widespread practice of lying at the border. Occasionally, blueprints and other documents have been seized at the border, although these are increasingly being transferred electronically.

A more problematic issue that is unlikely to be easily addressed under the Free Trade Agreement is the difficulty facing Canadian and American engineers in becoming accredited as professional engineers. Ontario engineers must be accredited in each state in which they work, a process which requires the setting and passing of exams. Specialized Canadian engineers in mid-career find it difficult to pass a comprehensive exam that covers all aspects of a broad field of engineering. The Ontario accreditation of U.S. engineers simply requires an application to the Association of Professional Engineers of Ontario.

The lack of standardization among design codes and the lack of bilateral acceptance of test data for the purpose of obtaining permits was also cited as costly and time-consuming barriers to the free movement of EP services, particularly in rapidly changing areas such as toxic wastes. In the more traditional EP industries, this is less of a problem, as more uniform, international standards have been derived over time. The Free Trade Agreement proposes continued efforts to harmonize standards between Canada and the United States.

### 5.7.3 Impact of Free Trade

Federal government officials at DRIE feel that the Ontario engineering and consulting services in the EP sector are world-competitive, and that they will benefit from the removal of trade restrictions. Consultants we spoke with were less confident that any significant benefits would be achieved. Some felt that more work now handled by their U.S. offices would be undertaken by Canadians. Others believe that local residents will continue to provide the bulk of the services in both countries.

In other service areas, the need for local employees for waste hauling and disposal guarantees that most of the Ontario demand will be met by Ontario branches of waste management firms, whether these firms are based in Ontario, other provinces, or in the U.S.

# CHAPTER 6
# EP INDUSTRY ISSUES AND THE ROLE FOR GOVERNMENT

## 6.1 Introduction

In addition to the issues raised in the course of our review of the EP industry's growth prospects and competitiveness, we were asked by the Ministry of the Environment to survey both purchasers and suppliers in the Ontario market to identify areas of concern on both sides of the market. Although we understand that the Ministry has already been engaged in a comprehensive consultation process with industry representatives in designing the new legislation, we were asked to speak to purchasers from a range of industries for their views on the technological needs posed by tightening government regulations on water pollution (under the Municipal-Industrial Strategy for Abatement, or MISA) and air quality (under the Clean Air Program, or CAP). Suppliers were also questioned on their views of current government policies in this area, and on the potential for government initiatives to foster the growth of Ontario EP industry capabilities. In this chapter, we report on the varied responses received in the course of our interviews.

In addition to the concerns raised by purchasers and suppliers, this study points to the need for a more thorough effort by Statistics Canada to track both expenditures and production in the field of environmental protection. Production data would be improved if environmental protection equipment was classified as a separate industry within the machinery and equipment industry sector. Since environmental protection appears to be an issue of growing importance in Canada and other countries, improving our knowledge of activity in this sector is likely to be of significant benefit to public policy-makers in the future.

## 6.2 Purchaser Concerns

In general, environmental officials with the major industries involved in pollution control remain uncertain as to the ultimate implications of the trend towards tighter regulations in Ontario. Beyond the need for improved monitoring of effluents, industry engineering personnel felt that the actual abatement procedures that will be followed under both MISA and CAP are currently undefined.

In particular, while industry officials are aware of the general concept of the regulations, requiring the adoption of the Best Available Technology Economically Achievable (BATEA), how these regulations will work in practice is still unclear. Should the regulations go no further than the process now underway in the United States, there should be no major technological difficulties. Otherwise, the prevailing view is that long lead times will be required to implement the new standards economically. The remainder of this section provides some examples of particular industries in which we conducted interviews that capture the general views of industry as a whole.

In the **pulp and paper industry**, for example, respondents viewed the MISA and CAP programs as being adaptations of existing American legislation. U.S regulatory authorities have defined BATEA for wastewater control as extended aeration and sludge treatment.

Should the requirements be similarly defined in Canada, the technology to treat effluents will generally be available to the industry, including some products that could be purchased from local manufacturers. However, there are some areas where the simple adoption of U.S. technology designed for American applications that will not work well in Ontario. For example, effluents from thermo-mechanical pumping plants are treated in aeration basins, but at lower temperatures, the biological activity involved in aeration drops to ineffective levels. As a result, according to one wastewater treatment equipment purchaser, some techniques that detoxify effluents in the United States will work for as little as six weeks per year in Northern Ontario.

Furthermore, some industry participants are concerned that the regulations will be interpreted as requiring much more stringent controls than now practiced in the United States. They interpret statements by the Minister as indicating the government's intention to require the removal of all toxic material from effluent. Should this be the case, their view is that the required technology would not be available, either in Ontario or elsewhere. While the industry has moved towards process changes and reduced usage of chlorine in bleaching, they believe that such measures cannot succeed in entirely eliminating chlorinated hydrocarbons in their effluents.

There is also a concern that the previously cooperative spirit between Ministry regulators and the industry is giving way to a more confrontational approach that, in these purchaser's views, will lead to less effective consultation towards efficient regulations. Their view is that some sort of "political saw-off" between environmental concerns and industry economics, of the variety they perceive to have been reached in the U.S., is necessary for the regulations to work.

**Petroleum** refining companies we contacted shared the general uncertainty concerning the implications of regulatory change for their sector, although industry participants appear to be somewhat more confident concerning how the process will ultimately work itself out. The MISA regulations are not viewed by the industry as requiring significant new control efforts, as the petroleum industry is already ahead of municipalities in adopting secondary biological treatment technologies and feels it should not be required to go any further until other emittors have caught up. There is less understanding of how the more recently-announced CAP will affect the industry.

Many firms in this industry are able to self-supply much of the design work that has been required in the past to meet environmental regulations. With the exception of laboratory services, one major refiner reported that they have designed all of their own water treatment facilities, sulphur plants and soil clean-up projects. Laboratory services are thought to be somewhat under-supplied, with slow turn-around times for analyses. As in other areas, petroleum refiners usually have to import much of their instrumentation and analytical equipment.

**Chemical** industry environmental officials were less certain that the technologies would exist to meet the yet-to-be-defined regulations, even in the area of monitoring. In common with firms in the petroleum industry, some of the major chemical firms are able to self-supply some of the engineering design work that would be required to alter processes for improved environmental performance. However, there is a general concern over the degree to which existing facilities will have to retrofit to comply with new regulations, since wholesale changes could make some existing operations unprofitable. Our respondents shared the view of those in other industries that the technologies would exist if MISA and CAP merely require the Ontario industry to meet U.S. standards, but doubt whether they could soon go much beyond these standards using presently available technologies without facing prohibitive costs. Chemical industry respondents also mentioned their concerns that the overall regulatory process is becoming more adversarial and in their view, less effective as a result.

Even where abatement expenditures are made, pollution control in the industry is thought by industry participants to be a difficult task, since most chemical manufacturing processes leave trace levels of reactants. Using scrubbers to remove them from the air leaves contaminated water behind. Biological treatment of effluent water removes what is believed by chemical industry engineers to be an acceptable percentage of contaminants, but presents the problem of disposing of the sludge and the "bugs" that remain suspended in the run-off.

**Mining and Metals** firms confirm the general level of uncertainty over the new regulations. Industry officials noted that most of the discussion between the industry and the Ministry to date has been focussed on sampling and analysis, rather than on the technologies that will be adopted for abatement and control. Again, these respondents stressed the difficulties they would have in finding technologies to exceed prevailing U.S. categorical effluent standards.

### 6.3 Supplier Concerns and the Role for Government[1]

In general, the industry believes that government regulations play a key role in shaping the environmental protection industry in both Canada and the United States. A change by the U.S. Environmental Protection Agency (EPA) in specifications for residual chlorine in wastewater, for example, would be sufficient to trigger activity among firms selling UV light systems, ozonation equipment and sulphur dioxide de-chlorination equipment. The proposed changes to Regulation 308 and MISA are expected by Ontario industry participants to be the key future driving forces for local manufacturers and service firms.

Most suppliers felt confident that they could meet many of the technological requirements arising from the new regulations, as they expect that the ultimate regulations will not require industries and municipalities to exceed the standards already in place, if not always enforced, in the United States. Ontario, in turn, is viewed as setting the stage for parallel legislation in other provinces. Many feel that industries could retrofit and clean up processes to meet legislated targets, and that this need not involve the large dollar figures which the affected industries will inevitably claim.

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[1] It should be noted that in this section, we report the concerns and perceptions of suppliers we contacted. We have not attempted to independently verify the accuracy of these perceptions.

The approach of following the American lead was thought to be detrimental to the EP industry in Ontario. By taking the lead in regulations, if not in enforcement, the U.S. stimulates its firms to lead in the development of technologies, which can then be exported. In some fields of pollution control, the U.S. is viewed as being five years ahead of Ontario. When seen against the views of purchasers, it appears that the most beneficial approach for both suppliers and purchasers involves being at the leading edge in terms of announcing future targets for environmental protection, but allowing sufficient lead times before new standards come into effect to allow for the efficient design and development of appropriate technologies in Ontario.

Both the approvals process handled by the Ministry, and the design specifications made by consulting engineers, are perceived by EP suppliers to reinforce the adoption of existing U.S. technologies in Canada and forestall the development of new EP technologies in Ontario. Some firms felt that although the regulations specified by the Ministry mention only end-use performance, in practice approvals are granted on the basis of meeting design requirements. The perception of suppliers (which we have not verified) is that new systems being tried in the U.S. on experimental, pilot projects would not be approved in Ontario.

Thus, while encouraging research on the one hand, the Ministry is viewed by suppliers as promoting the conservative use of existing technologies through its approvals process (by favouring the adoption of old technologies over experimental systems), and by lagging behind the U.S. in promulgating new regulations. A similar conclusion was reached by the Task Force on Environmental Protection Technologies (1983). Consulting engineers also promote this conservatism, according to equipment manufacturers, by specifying existing technologies and resisting innovative Ontario equipment that has not been applied elsewhere. Similarly, engineers at multinationals tend to copy designs used in parent company plants, reinforcing the use of imported equipment.

A problem that was mentioned by a few respondents concerned the lack of attention given to Canadian content by virtually all municipalities. It was suggested that price-advantage policies would help domestic manufacturers and would bring Ontario municipalities more in line with those of other countries. Others also suggested that municipalities should be given less latitude by the Ministry, since what they view as lax standards have sometimes led municipalities to adopt low-cost, but ineffective equipment to the detriment of suppliers of better, but more expensive technologies.

There is considerable government involvement in many of the 'high tech' aspects of solid and hazardous waste disposal. Individual departments within the federal government are responsible for environmental assessment and maintenance of federal lands, with Environment Canada having the mandate to establish general guidelines and standards. Provincial governments are responsible for provincial lands and each is establishing guidelines and legislation. The environmental assessment personnel and chemists with whom we spoke felt that it was very difficult to 'nail down' the provincial ministries regarding what is and is not acceptable in the area of hazardous waste disposal. The provincial ministries, on the other hand, have to receive public input into the establishment of the guidelines and this is proving to be a time consuming process. As a result, highly toxic chemicals such as PCB's have yet to be destroyed in Canada and they continue to accumulate and be stored on a temporary basis.

In terms of direct government assistance to the EP industry, participants felt that this was of secondary importance to the timely development and enforcement of environmental legislation. Grants and research funding cannot have the impact that will be produced by EP legislation, by tougher fines placed on violators, and by ensuring that enforcement is not a cyclical phenomenon that is neglected each time there is a business slowdown. However, a number of firms we contacted had already participated in existing federal and provincial programs for research and development, and there was a fairly broad-based support for a greater Ontario government role in encouraging the development of new EP goods and services in the province.

One successful Ontario manufacturer of instrumentation developed its product in conjunction with personnel from the National Research Council and maintained company representation on the board of the Canadian Standards Association. This company felt that the strong competition of American, German, Japanese and British firms merited the active involvement of the Ontario government in support of increased R&D and exports.

The Trade Export Fund (of the Ministry of Industry, Trade and Technology), the Export Manager for Hire program, and the College Intern program were all felt to be very useful and of great value to this company. Others cited the federal government's IRAP program as being particularly effective. However, these programs were felt to be small relative to the kind of push to the industry provided by the American Superfund program.

Research and development assistance appears to be more of a concern in select, high technology components of the EP industry. Most air pollution firms are involved in the production of fairly standard products with minimal innovation and undertake only modest R&D expenditures as a result. Trade volumes are quite low in these industries because of the local fabrication and air content of most products, and thus the requirement for government export assistance is also limited. These two limitations, however, do not apply to instrumentation manufacturers where technological and trade assistance would be of great value.

Most of the foreign-owned companies with whom we spoke have very little R&D capability in Ontario, though occasional product improvements are not unusual. Coupled with the absence of a mandate to export for these branch plants, this feature of branch plant operations in the EP areas is thought to be a factor limiting the potential success of government policies designed to promote Ontario exports from these multinationals. By taking the lead in developing regulations, the government might be in a better position to use other incentives to encourage multinationals to undertake research and product development in Ontario, rather than following the lead of their parent companies who have already reacted to earlier U.S. regulations. The export performance of domestically-based firms might also be similarly enhanced.

In some high technology areas where Canadian companies or branch plants feel that they cannot compete with large U.S. research budgets, industry participants feel that the government should encourage technology licensing agreements.

Several respondents felt that government R&D and export assistance programs involved too much paperwork and were thus ironically restricted to bigger companies who could afford to have an individual dedicated full-time to completing forms and communicating with the appropriate individuals within the government. Ironically, large multinational companies also felt that they were unlikely to qualify for government initiatives, which were viewed as favouring domestically-based firms. As one respondent stated, the message they receive is that "you're not Canadian and you have profits; if you want to do something, you are on your own".

Other respondents echoed this view that the government was reluctant to support anything that had too strong a possibility for success, viewing the possibility of profits as a sufficient reward despite considerable risks to be faced by the company undertaking the development of a new technology. In general, the industry feels it would benefit from greater support for pilot projects, both in funding and in granting approval for the use of new technologies. Such support already exists in the United States. Lorenz and Ropes (1986) cite an EPA program under the Clean Water Act which has provided over $140 million federal funding over the last 8 years for innovative municipal wastewater treatment plants.

Equity roles are felt to be too risky for government in a political sense and such ownership positions often burden the company's momentum and flexibility with unwanted bureaucracy. Tax incentives for R&D are described as desirable though subject to abuse by people who "don't raise a test tube". In instances where small companies are struggling to get products to market, tax concessions are generally the last thing on people's minds, while grants would potentially play an invaluable role in helping the company achieve its goal. The Ontario Technology Fund was described by one company as "a real shot in the arm" at an opportune time. Most firms felt that direct grants for R&D, prototype development and pilot projects were the most effective methods of government support.

Others noted that support for basic research has the potential for industrial development as well. Many of Ontario's small, entrepreneurial firms in the EP sector were spinoffs from University research projects.

In the area of marketing, there is general support in the industry for government assistance. This could include trade missions and assistance in the making of connections with knowledgeable foreign distributors and domestic design engineers. The provision of financial and other assistance to link up with distributors and partners in the U.S was also thought to be a valuable role for the Ontario government by some, but others felt strongly that incoming missions (trade shows put on for visitors from other countries) would provide better return for the government's expenditure than would outgoing missions (Canadian trade shows put on in foreign countries). In smaller companies, it is often difficult for the key executive or marketing manager to leave the office for 2 weeks to "go flit around some foreign country". Furthermore, incoming missions allow companies to put on top quality displays of products, laboratories, plants, and personnel.

Government purchasing is also an area of potential support to the domestic industry. The Ontario government funded numerous water and wastewater projects during the 1970's, contributing to the high capability which generally exists in the industry today. Further construction, expansion, and upgrading of treatment facilities will obviously benefit this branch of the EP industry, which supports this policy.

One specific suggestion regarding solid and hazardous waste disposal was that MOE should be offering special packages to private carriers to encourage recycling. Currently the ministry offers packages to municipalities aimed at encouraging recycling. For example, in Simcoe, MOE recently offered equipment write-off and purchase incentives to the municipality, according to an official with a private sector waste hauling company.

The feeling expressed to us was that MOE should also provide incentives to private haulers. It is currently not in the interests of private haulers to use compactors or to recommend the use of compactors to its shopping centre or industrial accounts, as this reduces the volume of waste hauled, the frequency of pick-ups, and the dollars of hauling revenue. Yet, it is clearly in the interests of the government to promote waste volume reductions. The industry advocates rapid compactor write-offs, for example, or grants toward the purchase of compacting or recycling equipment by haulers, as a means of encouraging the efficient handling of solid wastes.

In evaluating the merits of recycling versus conventional garbage disposal, it was suggested by many companies that MOE must consider societal goals and landfill longevity as well as direct costs and benefits. By incorporating landfill longevity into evaluations, recycling proposals and their respective costs and benefits will be cast in a different light. In general, the waste disposal industry also needs the Ministry's support to counter the not-in-my-backyard sentiment that prevents projects from going ahead.

# CHAPTER 7
# ENVIRONMENTAL PROTECTION IMPACT MODEL

## 7.1. Introduction

### 7.1.1 Purpose

In developing and defending its policies, The Ontario Ministry of the Environment is often called upon to evaluate the economic implications for the province arising from environmental protection regulatory changes. A standard, straightforward approach for measuring economic impacts which is often employed in this context is the use of multipliers derived from an input-output framework. Based on this approach, Woods Gordon has developed an Environmental Protection Impact Model (EPIM) to assist the Ministry in deriving required impact estimates. In this case, the impacts are in the form of jobs and income created in the supply of environmental protection products, that could help to offset some of the economic costs to the province of tighter environmental regulations.

The EPIM, described in this chapter and incorporated into a Lotus-based spreadsheet on the accompanying diskettes, is designed to assist policy-makers in estimating the impacts arising from a wide range of potential regulatory changes which the Ministry of the Environment might consider, including those affecting air quality, solid and liquid wastes and water treatment standards. For any such regulatory change, the step-by-step guide to data collection and analysis outlined in this chapter will lead to an estimate of the direct and indirect job and income creation generated in the province by Ontario purchases of pollution control products. These economic spinoffs, and the direct benefits of an improved environment, can then be set against the claims of economic costs from tighter environmental standards to help justify environmental legislation.

Of course, for any proposed regulatory change, the actual expenditures that will be required to meet the regulation will be known only approximately in advance of the regulation coming into force. In addition, the model outlined herein can only be expected to approximate the spinoff effects from environmental expenditures, as would be the case with any alternative approach. Thus, estimates obtained using the EPIM, should be viewed as "orders of magnitude" values for the actual economic impacts of environmental protection spending.

### 7.1.2 Organization

Including this Introduction, the chapter is divided into four Sections (plus appendixes). It provides documentation for the microcomputer-based EPIM model which has been provided to the Ministry on a computer diskette containing the multiplier data and the EPIM structure. Section 7.2 contains a brief description of the overall theoretical approach – input-output modelling – including a short summary of the assumptions and caveats that underlie this standard method of economic impact assessment.[1] The reader who is already familiar with input-output analysis may choose to skip this section. Section 7.3 describes the EPIM and reviews the steps that will be followed in estimating the impact of specific environmental regulatory changes, and serves as a guide to the data included on the diskette and in Appendix II Section 7.4 discusses how the EPIM can be updated in the future. The Appendix I contains the survey formats necessary to implement the approach outlined in Section 7.3, and Appendix II provides a copy of the printout from the EPIM.

## 7.2 Input-Output Methodology

### 7.2.1 Introduction

The Environmental Protection Impact Model (EPIM) uses Statistics Canada's *Interprovincial Input-Output Model* to derive appropriate multipliers to estimate the impacts of environmental protection expenditures on the Ontario economy. In this section, we briefly review the assumptions, benefits and caveats that underlie this approach to economic impact modelling.

Input-output modelling is one of the leading approaches to estimating the impact of government policies and other developments on employment and incomes. It is a special case of a more general (but far more costly) modelling approach known as general equilibrium analysis, which attempts to model all of the linkages between the various sectors of the economy. Thus, general equilibrium models account for the fact that, as one industry increases its output of a particular commodity, it will at the same time increase its demand for labour and the various commodities that serve as inputs into its production process (i.e., raw materials, machinery and equipment). The firms that provide the additional inputs will, in turn, have to purchase additional quantities of commodity inputs and labour.

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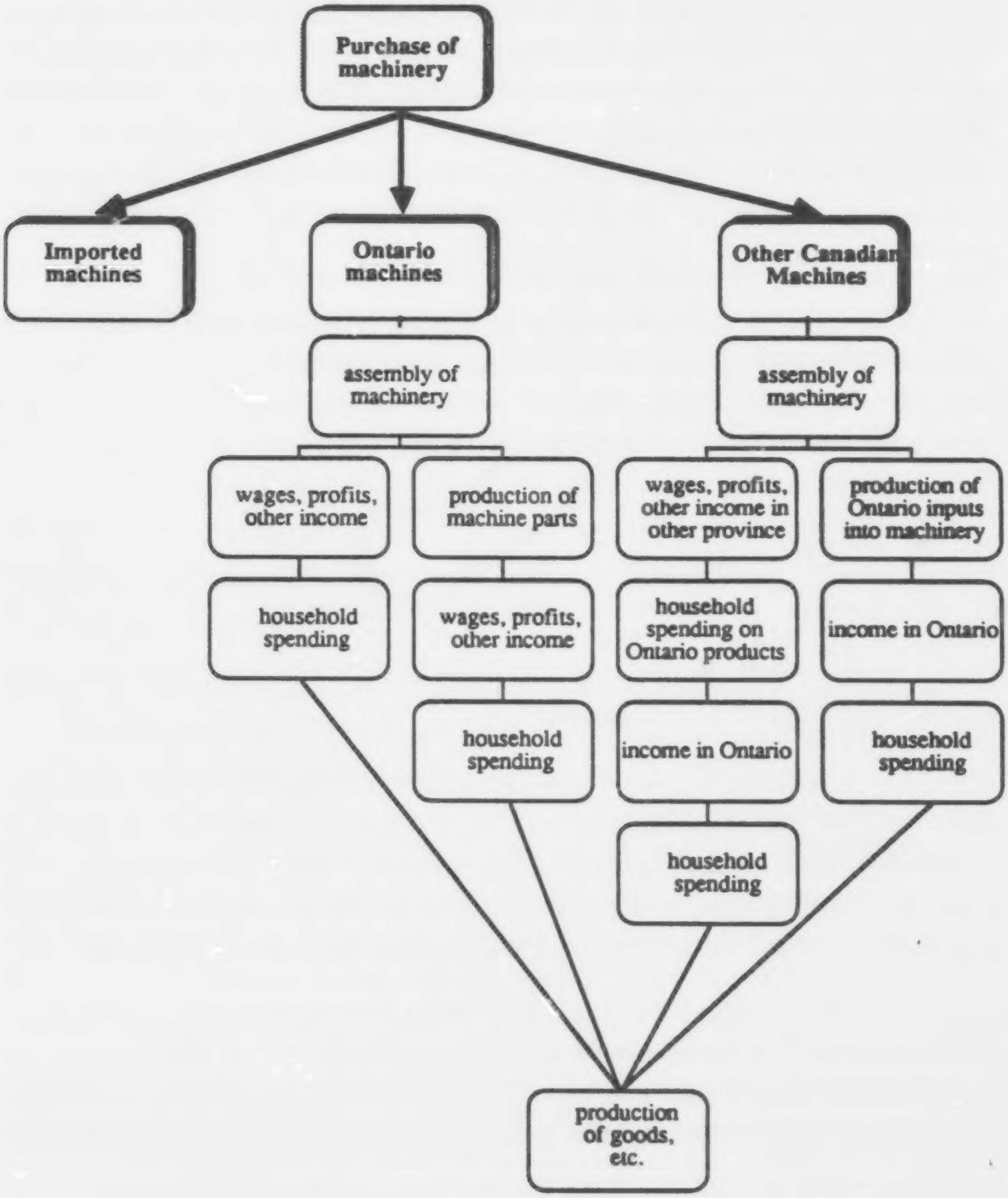
[1] See for example, Management Information Systems Inc. (1986)

Input-output models track all of these linkages, but make the simplifying assumption that all of the relationships are linear: each unit of output by a given industry or of a given product uses a constant mix and proportion of inputs from other industries, and a constant labour input. Thus, the model ignores the possibility of economies (or diseconomies) of scale – i.e., decreases (or increases) in input requirements per unit of output as production expands.

Similar to other general equilibrium approaches, input-output modelling assumes that suitable excess resources are available to meet any increase in demand. The model therefore ignores the potential for labour shortages or capacity constraints, and is thus most applicable during periods in which the economy is not running at full steam.

## FIGURE 7.1
## SIMPLIFIED REPRESENTATION OF THE INPUT-OUTPUT MODEL


Purchase of machinery
Imported machines
Ontario machines
Other Canadian Machines
assembly of machinery
assembly of machinery
wages, profits, other income
production of machine parts
wages, profits, other income in other province
production of Ontario inputs into machinery
household spending
wages, profits, other income
household spending on Ontario products
income in Ontario
household spending
income in Ontario
household spending
household spending
production of goods, etc.

The chief advantage of input-output models over broader macroeconomic models is that they allow for a high level of industry detail to be captured. In addition, unlike dynamic, macroeconomic models, input-output models depict long-run equilibrium positions. The advantage of this approach in this case is that the models are essentially dateless. Except for the need to make a straightforward adjustment for inflation (since a given nominal amount of spending will have a lesser job-creation impact over time), the model can be applied in any year, and does not have to be constantly updated to provide a reasonably accurate picture of the economic impacts that result from environmental protection spending.

The method of economic impact assessment proposed here has the virtue of being consistent with the usual practice of obtaining such estimates for other purposes. In particular, most economic impact analyses conducted for industry groups make use of this technique to account for the economic spinoffs of increases in their production in Ontario, or the job losses in the province as their own activity is reduced. Thus, it likely that if an industry group estimates the *negative* job spinoffs of production declines resulting from EP requirements, they would be most likely to be using an input-output framework to account for spin-off effects. The Ministry's estimates of the *positive* spinoffs

of EP spending would therefore be on a consistent basis with most estimates of job losses from environmental costs.

While we focus on the positive spinoffs of EP spending in this Chapter, the model could be used by the Ministry to calculate the negative spinoffs of reductions in business investment spending or output caused by tighter environmental regulations. This would entail entering negative values in the expenditure columns, representing reductions in purchases by Ontario firms of their production inputs or machinery and equipment.

Input-Output Models have been applied in other jurisdictions to estimate the economic spinoffs of environmental protection spending. For example, a study by Management Information Systems Inc. (1986) used a U.S. I/O model to simulate the output and job creation associated with American investment in pollution abatement and control.

### 7.2.2 How Input-Output Models Work

Input-output models are based on data derived in National Income Accounting, the basis for estimates of the volume of economic activity in a country (or province). The model is based on detailed estimates of the inputs used by each industry in the production of individual types of commodities. As noted above, the production of any one unit of a commodity is assumed to require a constant mix of inputs of labour and other commodities used as raw materials, machinery or equipment.

Statistics Canada's *Interprovincial Input -Output Model* [1] tracks the input requirements for the production of each of 92 different commodities by 41 industry groups. Some of the commodity classifications of particular relevance to the environmental protection sector include scientific equipment, business services, fabricated structures, boilers and tanks and various categories of metal, plastic and rubber products.

The model also tracks the province of production for each unit of the inputs used in supplying a purchaser in a given province. Thus, for example, the model allocates each dollar spent on boilers and tanks in Ontario to the production of inputs from Ontario, the other provinces, and imports.

Given these estimates, the model is able to derive the economic impact of the purchase of $1 of any of the 92 commodities in Ontario The initial purchase is traced back to the input content used in meeting Ontario demand. The production of the final product and its inputs in turn generates incomes, which are then spent on other commodities, creating further economic activity and thus further incomes and spending; these indirect effects are incorporated into the "closed" version of the model used here. The final model estimates give the total direct and indirect job and income creation that resulted from the initial $1 purchase, broken down by province.

These commodity-based estimates assume that only the location of the purchase (i.e., Ontario) is known; the model uses the average distribution of production for each commodity to estimate where the product will actually be produced. As a result, for some commodities that are usually imported from outside the province, the GDP and employment impact in Ontario will be quite small, while products that are usually produced locally (particularly services) the multipliers are much higher.

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[1] We have applied the "closed" version of the model. This version includes the induced impacts on GDP resulting from the spending by households of the income received in satisfying each increase in demand.

The accuracy of our approach will depend on the degree to which environmental protection commodities are similar to others in the same group in terms of their geographical distribution of production. The model implicitly assumes, for example, that purchases of water quality testing instrumentation entail the same degree of Ontario content as the average of all scientific instruments. Based on the necessarily approximate results of our survey of purchasers, we believe that the impact multipliers appear to be reasonable. The model also relies on structural relationships between industries (i.e., the degree to which each industry serves as a supplier to the others) that existed in 1979 to estimate spinoff effects; while these relationships do change over time, they are likely to remain sufficiently stable to permit 1979 values to proxy for the current industrial structure.

In some cases, the government will know that the product is in fact going to be produced in Ontario. In these cases, since the commodity-based model assumes only the usual portion of the product would be Ontario produced, the model would underestimate the economic impact on the province.

In these cases, a second set of multipliers should be used. These translate each dollar of production or revenue of Ontario industries (divided into 43 industry groups) into total direct, indirect and induced GDP and employment in Ontario. The multipliers in this second input-output table are higher, since the product is being produced in Ontario.

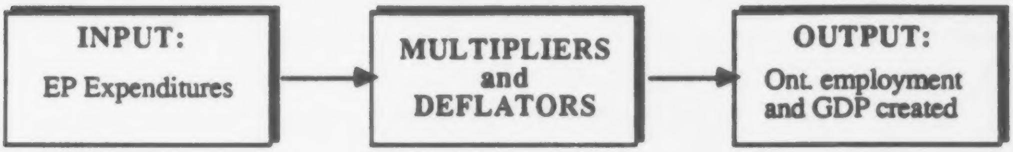
A third type of impact will arise if the firm employs additional staff (e.g., environmental engineers) as a part of its response to environmental regulations. A multiplier translating the total direct, indirect and induced employment and GDP creation in Ontario is included in the model to capture the impact of such hiring.

## 7.3 Using the Environmental Protection Impact Model

### 7.3.1 Introduction

The EPIM translates estimates for expenditures on environmental protection (broken down into repeat purchases and one-time expenditures) into estimates of permanent and one-time employment and GDP impacts, using multipliers derived from an input-output framework and appropriate adjustments for inflation. The basic structure of the EPIM is illustrated in Figure 7.2.

**FIGURE 7.2**
**The Environmental Protection Impact Model**



The model diskette provides all of the general input-output data necessary for estimating the Ontario impact of the environmental protection expenditures of Ontario companies and municipalities. In addition to these general data, the application of this model to a specific environmental policy change will require the assembly of data on the spending generated by the policy. In this section, we provide a detailed, step-by-step guide to obtaining the necessary data, applying it to the model, and interpreting the results.

There are two basic steps to be undertaken in estimating the impact of changes in environmental protection spending on the Ontario economy:

(1) Translation of a regulatory policy change into expenditure requirements by major classes of equipment or services;

(2) Translation of Ontario purchases of commodities into total direct and indirect job and income creation.

### 7.3.2 From Regulations to Expenditures

The first step in the process will be undertaken by the Ministry of the Environment on a case-by-case basis, using the approach we outline in this section. The approach will vary depending on the information already in the Ministry's hands at the time the regulatory change is instituted.

In some cases, where the regulatory change mandates the use of a particular good or service, the Ministry may already know the total expenditures that the policy will require to a reasonable degree of accuracy. In such cases, the Ministry could proceed directly to step (2) in the analysis.

In other cases, however, while the Ministry may be aware of the general nature of the expenditures that will be required to meet the regulation, it will not know the cost of instituting the changes or the extent that service purchases will be required along with the equipment. In these cases a survey of the affected firms or municipalities will be required.

This survey would be conducted as follows:

(1) The Ministry would use the Certificates of Approvals list to identify the universe of affected establishments or municipalities. These certificates will identify all establishments engaged in processes that emit the type of pollutant in question.

(2) In the event that a very large number of establishments are involved, a sample would be selected from each of the representative industries. Dun and Bradstreet or other corporate directories would be used to ascertain the share of the industry represented by the sample.

(3) Each establishment in the sample would be surveyed in writing or by telephone (where the number of firms is very small), and will be asked to estimate the expenditures that will be required (by commodity category) to meet the new regulation. If the source of the purchases is known to be an Ontario company, the firm would be asked to indicate the name of the supplier. A possible standard form for a written survey is provided in Appendix I to this report. The covering letter for the survey should emphasize that the Ministry requires their cooperation in order for the government to have an understanding of the potential costs of the new regulation to their establishment. In fact, in view of the detailed information that the Ministry will be seeking, we would recommend that potential respondents to a written survey be contacted by telephone first, in order to explain the purpose of the survey and gain their cooperation.

(4) Where only a sample of firms is surveyed, the results would have to be grossed up to be representative of the universe of companies or municipalities. The method to be applied will depend on whether or not the required goods and services vary with the size of the firm. This will have to be ascertained through discussions with industry

participants or officials from EP suppliers. Where the expenditures are thought to be roughly proportional to output, the gross-up will divide the sample expenditures by the share of industry output accounted for by the surveyed firms. In other cases, each firm will require the same expenditure regardless of their size. In these cases, the gross-up will be accomplished by dividing by the proportion of firms surveyed to the total number of firms.

(5) An alternative approach, for a rougher economic impact assessment, would be to rely on industry associations, consulting engineers, and EP industry officials to identify an estimate for the required expenditures by category. Industry officials should be advised that if they wish to claim that the regulatory change will impose major costs for their industry, they must identify what expenditures will be required. In this way, the Ministry will obtain data on the potential spinoffs (i.e. Ontario purchases) of EP regulations whenever they receive concerns on the costs of EP programs to polluters.

This process will yield a table of expenditures classified into 92 commodities, broken down into repeat purchases and one-time expenditures, and divided into those products that will be purchased from a known, Ontario supplier and others. Table 14 below provides a listing of these commodities, including a description of some of the types of environmental protection goods and services that fit into the particular commodity. In most cases, the expenditures will be concentrated in a fairly small number of categories. Where a secondary or tertiary good is purchased (e.g.waste hauling services), only the final good category is used, rather than the many categories that make up its inputs (trucks, tires, steel etc.). Where a construction firm or engineering consulting firm makes major goods purchases as a part of a contract with the company undertaking the environmental protection activity, it will be more accurate (although not essential) to separate out large expenditure items from the overall cost of the service provided, and then enter them in the appropriate commodity category.

Our experience has been that while one should take care in classifying expenditures, the choices made between similar categories will usually not appreciably alter the order of magnitude of the impact estimates. The purpose of economic impact estimation is not to develop a precise point estimate, but rather to obtain an understanding of the range of possible employment and income spinoffs associated with a project.

## Table 14

### Environmental Protection Impact Model
### Commodity Categories

| Commodity Class | Examples of EP Goods and Services |
|---|---|
| 1. Grains | |
| 2. Live Animals | |
| 3. Other Agricultural Products | |
| 4. Forestry Products | |
| 5. Fish Landings | |
| 6. Hunting and Trapping Products | |
| 7. Iron Ores and Concentrates | |
| 8. Other Metal. Ores/Concentrates | |
| 9. Coal | |
| 10. Crude Mineral Oils | |
| 11. Natural Gas | |
| 12. Non-Metallic Minerals | |
| 13. Services Incidental to Mining | |
| 14. Meat Products | |
| 15. Dairy Products | |
| 16. Fish Products | |
| 17. Fruits/Veg. Preparations | |
| 18. Feeds | |
| 19. Flour, Wheat, Meal, other Cereals | |
| 20. Breakfast Cereals | |
| 21. Sugar | |
| 22. Misc. Food Products | |
| 23. Soft Drinks | |
| 24. Alcoholic Beverages | |
| 25. Tobacco Processed Unmanufactured | |
| 26. Cigarettes & Tobacco Mfg | |
| 27. Tires and Tubes | Truck tires |
| 28. Other Rubber Products | Rubber hoses and tubing |
| 29. Plastic Fabricated Products | Plastic hose, pipe sheet and fitting, containers |
| 30. Leather & Leather Products | |
| 31. Yarns and Man-made Fibres | |
| 32. Fabrics | |
| 33. Other Textile Products | |
| 34. Hosiery and Knitted Wear | |
| 35. Clothing and Accessories | |
| 36. Lumber and Timber | |
| 37. Veneer and Plywood | |
| 38. Other Wood Fabricated Materials | Prefab wood buildings, wood containers |
| 39. Furniture and Fixtures | |
| 40. Pulp | |
| 41. Newsprint and Other Paper Stock | |
| 42. Paper Products | Paper bags, boxes |
| 43. Printing and Publishing | |
| 44. Advertising, Print Media | |
| 45. Iron and Steel Products | |
| 46. Aluminum Products | |
| 47. Copper and Copper Alloy Products | |
| 48. Nickel Products | |
| 49. Other Non-Ferrous Metal Products | |
| 50. Boilers, Tanks and Plates | boilers, tanks, water/steam heating equip. |
| 51. Fabricated Structural Metal Products | scaffolding, metal prefabricated buildings |

| | |
|---|---|
| 52. Other Metal Fabricated Products | metal pipes, fittings, sidings, pails, ash cans, containers, wire, chains, hardware, air heating eq, water tank heaters, fuel burning eq, custom metal working, forgings, valves, non-ferrous pipe fittings, gas/water meters, collapsible metal tubes |
| 53. Agricultural Machinery | |
| 54. Other Industrial Machinery | pumps, compressors, blowers, conveyers, hoists, ind. trucks/tractors/trailers fans, air circulators, air units, lubr. eq, ind. furnaces/kilns/ovens, refrigeration/cooling eq. scales, other machinery |
| 55. Motor Vehicles | commercial trucks |
| 56. Motor Vehicle Parts | truck parts |
| 57. Other Transport Equip | rail cars |
| 58. Appliances/Receivers - household | |
| 59. Other Electrical Products | data transmission equip, electronics, transformers, ind. electr. eq., electric wire |
| 60. Cement and Concrete Products | concrete, sand lime bricks, cement |
| 61. Other Non-Metallic Mineral Prod. | asbestos filters, insulation, porcelain insulators & plumbing,glass |
| 62. Gasoline and Fuel Oil | |
| 63. Other Petroleum and Coal Prod. | |
| 64. Industrial Chemicals | Chlorine, other chemicals |
| 65. Fertilizers | |
| 66. Pharmaceuticals | |
| 67. Other Chemical Products | Boiler chemicals, agricultural chemicals, , ind. chem. prep'tions |
| 68. Scientific Equipment | lab apparatus, measuring and control instruments |
| 69. Other Manufactured Products | |
| 70. Residential Construction | |
| 71. Non-Residential Construction | contracting for EP facilities construction |
| 72. Repair Construction | |
| 73. Pipeline Construction | |
| 74. Transportation and Storage | Waste hauling, storage, barges, rail |
| 75. Radio and Television Broadcasting | |
| 76. Telephone and Telegraph | data transmission services |
| 77. Postal Services | |
| 78. Electric Power | electrical utilities |
| 79. Other Utilities | water, gas utilities |
| 80. Wholesale Margins | |
| 81. Retail Margins | |
| 82. Imputed Rent-Owner Occ. Dwellings | |
| 83. Other Fin., Insurance, Real Est. | |
| 84. Business Services | consulting engineering, [illegible]p. rentals |
| 85. Education Services | employee training |
| 86. Health Services | |
| 87. Amusement and Recr. Services | |
| 88. Accommodation and Food Services | |
| 89. Other Personal and Misc. Services | construction eqiup. rentals |
| 90. Transportation Margins | |
| 91. Operating, Office, Lab and Food | lab supplies, spare parts and machinery maintenance services |
| 92. Travel, Advertising and Promotion | |

### 7.3.3 From Purchases to Economic Impact

The second stage in the analysis entails using the input/output model supplied by Woods Gordon to identify the direct and indirect job and income creation in Ontario that results from the purchases of EP goods and services. This estimate includes

**Sources of Supply: Please check one of the following boxes:**

**A:** ☐ All of the above commodities will be purchased from suppliers **outside** Ontario or from Ontario distributors of imported products:

**B:** ☐ **Some** or **all** of the above commodities will be purchased from **Ontario suppliers,** excluding Ontario distributors of foreign products.

**C:** ☐ We do not know where **any** of the commodities will be purchased

**If you checked B, please list the Ontario suppliers and the commodities to be purchased from each on the next page. Include products that you will buy from an Ontario firm if you are uncertain whether they are made here.** Use a separate entry for each commodity or supplier. Attach additional sheets if necessary.

| Commodity |  | $ of Purchases |  | Expected Supplier (Name of Company) |
|---|---|---|---|---|
| # (1-92) | Name | One-Time | Annual |  |
|  |  |  |  |  |

# APPENDIX II

# SAMPLE OUTPUT FROM THE ENVIRONMENTAL PROTECTION IMPACT MODEL

# EMPLOYMENT DEFLATORS

Table 1
IMPACT OF PURCHASE OF ENVIRONMENTAL
PROTECTION GOODS/SERVICES

| COMMODITY / INDUSTRY | GDP Deflator | GDP at Factor Cost ($1981 constant) 1979 | GDP at Factor Cost ($1981 constant) 1984 | GDP at Factor Cost (Current Dollars) 1979 | GDP at Factor Cost (Current Dollars) 1984 | Deflator 1984 | Deflator Current Year | Industry Price Indices | 1979 1971=100 | Current year (1987) 1981=100 | Link Factor | Current year (1987) 1971=100 | Current year Deflator |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Grains | | | | | | | | Vegetable Products | 114.8 | 84.6 | 1.359 | 114.97 | 1.00 |
| 2. Live Animals | | | | | | | | Animal & Animal Products | 143.7 | 119.0 | 1.558 | 185.40 | 1.29 |
| 3. Other Agricultural Products | | | | | | | | Vegetable Products | 114.8 | 84.6 | 1.359 | 114.97 | 1.00 |
| 4. Forestry Products | | | | | | | | Wood | 142.0 | 121.1 | 1.504 | 182.13 | 1.28 |
| 5. Fish Landings | | | | | | | | Animal & Animal Products | 143.7 | 119.0 | 1.558 | 185.40 | 1.29 |
| 6. Hunting & Trapping Products | | | | | | | | Animal & Animal Products | 143.7 | 119.0 | 1.558 | 185.40 | 1.29 |
| 7. Iron Ores & Concentrates | | | | | | | | Ferrous Metals | 135.9 | 108.8 | 1.370 | 149.06 | 1.10 |
| 8. Other Metal. Ores/Concentrates | | | | | | | | Non-Ferrous Metals | 162.2 | 102.3 | 1.779 | 181.99 | 1.12 |
| 9. Coal | | | | | | | | Mineral Fuels | 133.1 | 93.9 | 2.326 | 218.41 | 1.64 |
| 10. Crude Mineral Oils | | | | | | | | Mineral Fuels | 133.1 | 93.9 | 2.326 | 218.41 | 1.64 |
| 11. Natural Gas | | | | | | | | Mineral Fuels | 133.1 | 93.9 | 2.326 | 218.41 | 1.64 |
| 12. Non-Metallic Minerals | | | | | | | | Non Metallic Minerals | 116.0 | 127.9 | 1.654 | 211.55 | 1.82 |
| 13. Services Incidental to Mining | Services Related to Mineral Extract | 1,545.5 | 1,980.1 | 1,237.8 | 2,354.1 | 1.48 | 1.65 | | | | | | |
| 14. Meat Products | | | | | | | | Meat & Meat Products Industry | 243.1 | 118.0 | 2.596 | 306.33 | 1.26 |
| 15. Dairy Products | | | | | | | | Dairy Products Industries | 222.9 | 136.0 | 2.880 | 391.68 | 1.76 |
| 16. Fish Products | | | | | | | | Fish Products Industry | 262.2 | 141.2 | 3.270 | 461.72 | 1.76 |
| 17. Fruits & Vegetables Preparations | | | | | | | | Canned & Preserved Fruit & Vegetabl | 204.3 | 135.8 | 2.628 | 356.88 | 1.75 |
| 18. Feeds | | | | | | | | Feed Industry | 219.0 | 95.0 | 2.574 | 244.53 | 1.12 |
| 19. Flour, Wheat, Meal, other Cereals | | | | | | | | Flour & Prepared Cereals Industries | 246.6 | 119.5 | 3.241 | 387.30 | 1.57 |
| 20. Breakfast Cereals | | | | | | | | Flour & Prepared Cereals Industries | 246.6 | 119.5 | 3.241 | 387.30 | 1.57 |
| 21. Sugar | | | | | | | | Cane & Beet Sugar Industry | 216.6 | 100.2 | 2.773 | 277.85 | 1.28 |
| 22. Miscellaneous Food Products | | | | | | | | Food & Beverages Industries | 231.7 | 124.6 | 2.828 | 352.37 | 1.52 |
| 23. Soft Drinks | | | | | | | | Soft Drink Industry | 230.6 | 124.9 | 3.085 | 385.32 | 1.67 |
| 24. Alcoholic Beverages | | | | | | | | Distillery Products Industry | 147.6 | 132.0 | 1.814 | 239.45 | 1.62 |
| 25. Tobacco Processed Unmanufactured | | | | | | | | Tobacco Products Industries | 159.6 | 151.9 | 1.932 | 293.47 | 1.84 |
| 26. Cigarettes & Tobacco Mfg. | | | | | | | | Tobacco Products Industries | 159.6 | 151.9 | 1.932 | 293.47 | 1.84 |
| 27. Tires and Tubes | | | | | | | | Tires and Tube Industry | 158.4 | 107.6 | 2.128 | 228.97 | 1.45 |
| 28. Other Rubber Products | | | | | | | | Miscellaneous Rubber Products Indus | 183.0 | 125.8 | 2.530 | 318.27 | 1.74 |
| 29. Plastic Fabricated Products | Plastic products | 950.0 | 1,180.6 | 763.1 | 1,300.6 | 1.37 | 1.52 | | | | | | |
| 30. Leather & Leather Products | | | | | | | | Leather & Allied Products Industrie | 239.3 | 128.2 | 2.604 | 333.83 | 1.40 |
| 31. Yarns and Man-made Fibres | | | | | | | | Wool Yarn & Woven Cloth Industries | 204.9 | 120.6 | 2.485 | 299.69 | 1.46 |
| 32. Fabrics | | | | | | | | Wool Yarn & Woven Cloth Industries | 204.9 | 120.6 | 2.485 | 299.69 | 1.46 |
| 33. Other Textile Products | | | | | | | | Wool Yarn & Woven Cloth Industries | 204.9 | 120.6 | 2.485 | 299.69 | 1.46 |
| 34. Hosiery and Knitted Wear | | | | | | | | Hosiery Industry | 136.3 | 122.0 | 1.618 | 197.40 | 1.45 |
| 35. Clothing and Accessories | | | | | | | | Men's & Boys' Clothing Industries | 196.0 | 121.8 | 2.426 | 295.49 | 1.51 |
| 36. Lumber and Timber | | | | | | | | Sawmill & Planing Mill Products Ind | 274.7 | 119.2 | 2.309 | 275.23 | 1.00 |
| 37. Veneer and Plywood | | | | | | | | Veneer & Plywood Industries | 242.2 | 115.1 | 2.556 | 294.20 | 1.21 |
| 38. Other Wood Fabricated Materials | | | | | | | | Wood Industries | 260.8 | 121.8 | 2.430 | 295.97 | 1.13 |
| 39. Furniture and Fixtures | | | | | | | | Furniture & Fixtures Industries | 208.9 | 132.8 | 2.645 | 351.26 | 1.68 |
| 40. Pulp | | | | | | | | Pulp & Paper Industries | 258.2 | 126.5 | 3.340 | 422.51 | 1.64 |
| 41. Newsprint and Other Paper Stock | | | | | | | | Newsprint, Domestic Market | 224.4 | 136.2 | 2.891 | 393.75 | 1.75 |
| 42. Paper Products | | | | | | | | Paper & Allied Products Industries | 239.6 | 128.3 | 3.083 | 395.55 | 1.65 |
| 43. Printing and Publishing | Printing & Publishing | 2,890.1 | 3,154.7 | 2,318.8 | 4,136.4 | 1.63 | 1.81 | | | | | | |
| 44. Advertising, Print Media | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |
| 45. Iron and Steel Products | | | | | | | | Primary Metal Industries | 258.8 | 112.8 | 3.031 | 341.90 | 1.32 |
| 46. Aluminum Products | | | | | | | | Aluminum Rolling, Casting & Extrudi | 234.0 | 117.0 | 2.844 | 332.75 | 1.42 |
| 47. Copper and Copper Alloy Products | | | | | | | | Copper Rolling, Casting & Extruding | 201.8 | 108.5 | 2.103 | 228.18 | 1.13 |
| 48. Nickel Products | | | | | | | | Non-ferrous Metal Smelting & Refini | 303.9 | 106.5 | 3.495 | 372.22 | 1.22 |
| 49. Other Non-Ferrous Metal Products | | | | | | | | Non-ferrous Metal Smelting & Refini | 303.9 | 106.5 | 3.495 | 372.22 | 1.22 |
| 50. Boilers, Tanks and Plates | | | | | | | | Power Boiler & Heat Exchanger Indus | 274.9 | 141.5 | 3.055 | 432.28 | 1.57 |
| 51. Fabricated Structural Metal Products | | | | | | | | Fabricated Metal Products | 211.5 | 126.5 | 2.576 | 325.86 | 1.54 |
| 52. Other Metal Fabricated Products | | | | | | | | Fabricated Metal Products | 211.5 | 126.5 | 2.576 | 325.86 | 1.54 |
| 53. Agricultural Machinery | | | | | | | | Agricultural Implement Industry | 206.0 | 135.7 | 2.526 | 342.78 | 1.66 |
| 54. Other Industrial Machinery | | | | | | | | Miscellaneous Machinery & Equipment | 198.6 | 129.1 | 2.495 | 253.20 | 1.27 |
| 55. Motor Vehicles | | | | | | | | Motor Vehicles Industry | 161.4 | 135.8 | 1.862 | 252.86 | 1.57 |
| 56. Motor Vehicle Parts | | | | | | | | Motor Vehicle Parts & Accessories | 189.0 | 122.1 | 2.368 | 289.13 | 1.53 |
| 57. Other Transport Equipment | Transportation Equipment Industries | 7,306.3 | 8,515.6 | 5,723.4 | 10,657.7 | 1.60 | 1.78 | | | | | | |
| 58. Appliances/Receivers - household | | | | | | | | Record Player, Radio & T.V. Receive | 119.6 | 99.3 | 1.105 | 109.73 | 0.92 |
| 59. Other Electrical Products | | | | | | | | Electrical and Electronic Products | 172.4 | 121.8 | 2.040 | 248.47 | 1.44 |
| 60. Cement and Concrete Products | | | | | | | | Non Metallic Mineral Products Indus | 210.0 | 134.3 | 2.766 | 371.47 | 1.77 |
| 61. Other Non-metallic Mineral Products | | | | | | | | Non Metallic Mineral Products Indus | 210.0 | 134.3 | 2.766 | 371.47 | 1.77 |
| 62. Gasoline and Fuel Oil | | | | | | | | Refined Petroleum & Coal Products | 321.3 | 101.8 | 5.620 | 572.12 | 1.78 |
| 63. Other Petroleum and Coal Products | | | | | | | | Refined Petroleum & Coal Products | 321.3 | 101.8 | 5.620 | 572.12 | 1.78 |

Table 1
IMPACT OF PURCHASE OF ENVIRONMENTAL PROTECTION GOODS/SERVICES

| COMMODITY / INDUSTRY | ONE-TIME EXPENDITURE ($) | ANNUAL EXPENDITURE ($) | GDP MULTIPLIER | EMPLOYMENT MULTIPLIER (1979) | EMPLOYMENT DEFLATOR (1987) | EMPLOYMENT MULTIPLIER (1987) | ONE-TIME GDP IMPACT ($) | ANNUAL GDP IMPACT ($) | TOTAL GDP IMPACT ($) | ONE-TIME EMPLOYMENT IMPACT (person-years) | ANNUAL EMPLOYMENT IMPACT (person-years) | TOTAL EMPLOYMENT IMPACT (person-years) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Grains | | | 0.403 | 0.118 | 1.00 | 0.118 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2. Live Animals | | | 0.849 | 0.233 | 1.29 | 0.181 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3. Other Agricultural Products | | | 0.632 | 0.174 | 1.00 | 0.174 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4. Forestry Products | | | 0.936 | 0.362 | 1.28 | 0.282 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5. Fish Landings | | | 0.516 | 0.122 | 1.29 | 0.095 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6. Hunting & Trapping Products | | | 0.000 | 0.000 | 1.29 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7. Iron Ores & Concentrates | | | 0.156 | 0.060 | 1.10 | 0.055 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8. Other Metal. Ores/Concentrates | | | 0.595 | 0.118 | 1.12 | 0.105 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9. Coal | | | 0.007 | 0.003 | 1.64 | 0.002 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10. Crude Mineral Oils | | | 0.061 | 0.016 | 1.64 | 0.010 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11. Natural Gas | | | 0.058 | 0.022 | 1.64 | 0.013 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12. Non-Metallic Minerals | | | 0.611 | 0.178 | 1.82 | 0.098 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13. Services Incidental to Mining | | | 1.051 | 0.370 | 1.65 | 0.224 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14. Meat Products | | | 0.755 | 0.259 | 1.26 | 0.206 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15. Dairy Products | | | 0.818 | 0.268 | 1.76 | 0.153 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16. Fish Products | | | 0.085 | 0.033 | 1.57 | 0.021 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17. Fruits & Vegetables Preparations | | | 0.462 | 0.179 | 1.75 | 0.102 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18. Feeds | | | 0.487 | 0.160 | 1.12 | 0.143 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19. Flour, Wheat, Meal, other Cereals | | | 0.635 | 0.195 | 1.57 | 0.124 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20. Breakfast Cereals | | | 0.797 | 0.321 | 1.57 | 0.204 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21. Sugar | | | 0.242 | 0.078 | 1.28 | 0.061 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22. Miscellaneous Food Products | | | 0.353 | 0.136 | 1.53 | 0.089 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23. Soft Drinks | | | 0.922 | 0.336 | 1.67 | 0.201 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24. Alcoholic Beverages | | | 0.720 | 0.204 | 1.62 | 0.126 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25. Tobacco Processed Unmanufactured | | | 0.878 | 0.279 | 1.84 | 0.152 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26. Cigarettes & Tobacco Mfg. | | | 0.619 | 0.185 | 1.84 | 0.101 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27. Tires and Tubes | | | 0.567 | 0.221 | 1.45 | 0.153 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28. Other Rubber Products | | | 0.523 | 0.216 | 1.74 | 0.124 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29. Plastic Fabricated Products | | | 0.510 | 0.207 | 1.52 | 0.136 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30. Leather & Leather Products | | | 0.356 | 0.295 | 1.40 | 0.211 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31. Yarns and Man-made Fibres | | | 0.391 | 0.164 | 1.46 | 0.112 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32. Fabrics | | | 0.227 | 0.099 | 1.46 | 0.068 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33. Other Textile Products | | | 0.404 | 0.174 | 1.46 | 0.119 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34. Hosiery and Knitted Wear | | | 0.349 | 0.177 | 1.45 | 0.122 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35. Clothing and Accessories | | | 0.413 | 0.202 | 1.51 | 0.134 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36. Lumber and Timber | | | 0.423 | 0.170 | 1.00 | 0.170 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37. Veneer and Plywood | | | 0.315 | 0.134 | 1.21 | 0.110 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38. Other Wood Fabricated Materials | | | 0.702 | 0.296 | 1.13 | 0.261 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39. Furniture and Fixtures | | | 0.712 | 0.321 | 1.68 | 0.191 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40. Pulp | | | 0.375 | 0.118 | 1.64 | 0.072 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41. Newsprint and Other Paper Stock | | | 0.549 | 0.173 | 1.75 | 0.099 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42. Paper Products | | | 0.639 | 0.251 | 1.65 | 0.152 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43. Printing and Publishing | | | 0.756 | 0.310 | 1.81 | 0.171 | 0 | 0 | 0 | 0 | 0 | 0 |
| 44. Advertising, Print Media | | | 1.114 | 0.457 | 1.36 | 0.336 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45. Iron and Steel Products | | | 0.620 | 0.220 | 1.32 | 0.167 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46. Aluminum Products | | | 0.368 | 0.152 | 1.42 | 0.107 | 0 | 0 | 0 | 0 | 0 | 0 |
| 47. Copper and Copper Alloy Products | | | 0.554 | 0.159 | 1.13 | 0.141 | 0 | 0 | 0 | 0 | 0 | 0 |
| 48. Nickel Products | | | 0.628 | 0.166 | 1.22 | 0.136 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49. Other Non-Ferrous Metal Products | | | 0.389 | 0.136 | 1.22 | 0.111 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50. Boilers, Tanks and Plates | 1,000,000 | | 0.595 | 0.238 | 1.57 | 0.151 | 595,000 | 0 | 595,000 | 15 | 0 | 15 |
| 51. Fabricated Structural Metal Products | | | 0.770 | 0.290 | 1.54 | 0.188 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52. Other Metal Fabricated Products | | | 0.596 | 0.231 | 1.54 | 0.150 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53. Agricultural Machinery | | | 0.169 | 0.067 | 1.66 | 0.040 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54. Other Industrial Machinery | 2,000,000 | | 0.203 | 0.077 | 1.27 | 0.060 | 406,000 | 0 | 406,000 | 12 | 0 | 12 |
| 55. Motor Vehicles | | | 0.201 | 0.077 | 1.57 | 0.049 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56. Motor Vehicle Parts | | | 0.097 | 0.033 | 1.53 | 0.022 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57. Other Transport Equipment | | | 0.313 | 0.117 | 1.78 | 0.066 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58. Appliances/Receivers - household | | | 0.253 | 0.096 | 0.92 | 0.105 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59. Other Electrical Products | | | 0.374 | 0.142 | 1.44 | 0.099 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60. Cement and Concrete Products | | | 0.931 | 0.295 | 1.77 | 0.167 | 0 | 0 | 0 | 0 | 0 | 0 |
| 61. Other Non-metallic Mineral Products | | | 0.559 | 0.204 | 1.77 | 0.115 | 0 | 0 | 0 | 0 | 0 | 0 |
| 62. Gasoline and Fuel Oil | | | 0.131 | 0.089 | 1.78 | 0.050 | 0 | 0 | 0 | 0 | 0 | 0 |
| 63. Other Petroleum and Coal Products | | | 0.222 | 0.101 | 1.78 | 0.057 | 0 | 0 | 0 | 0 | 0 | 0 |

| COMMODITY / INDUSTRY | ONE-TIME EXPENDITURE ($) | ANNUAL EXPENDITURE ($) | GDP MULTIPLIER | EMPLOYMENT MULTIPLIER (1979) | EMPLOYMENT DEFLATOR (1987) | EMPLOYMENT MULTIPLIER (1987) | ONE-TIME GDP IMPACT ($) | ANNUAL GDP IMPACT ($) | TOTAL GDP IMPACT ($) | ONE-TIME EMPLOYMENT IMPACT (person-years) | ANNUAL EMPLOYMENT IMPACT (person-years) | TOTAL EMPLOYMENT IMPACT (person-years) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64. Industrial Chemicals | | 500,000 | 0.317 | 0.114 | 1.62 | 0.070 | 0 | 158,500 | 158,500 | 0 | 4 | 4 |
| 65. Fertilizers | | | 0.532 | 0.174 | 1.25 | 0.139 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66. Pharmaceuticals | | | 0.428 | 0.161 | 2.01 | 0.080 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67. Other Chemical Products | | | 0.447 | 0.161 | 1.62 | 0.099 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68. Scientific Equipment | | | 0.103 | 0.046 | 1.80 | 0.026 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69. Other Manufactured Products | | | 0.321 | 0.138 | 1.80 | 0.077 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70. Residential Construction | | | 0.999 | 0.351 | 1.41 | 0.250 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71. Non-residential Construction | | | 1.055 | 0.366 | 1.41 | 0.260 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72. Repair Construction | | | 1.027 | 0.403 | 1.41 | 0.286 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73. Pipeline Construction | | | 0.436 | 0.056 | 1.41 | 0.040 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74. Transportation and Storage | | | 0.738 | 0.272 | 1.63 | 0.167 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75. Radio and Television Broadcasting | | | 1.084 | 0.437 | 1.57 | 0.279 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76. Telephone and Telegraph | | | 1.131 | 0.330 | 1.57 | 0.210 | 0 | 0 | 0 | 0 | 0 | 0 |
| 77. Postal Services | | | 1.594 | 0.937 | 1.57 | 0.597 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78. Electric Power | | | 0.905 | 0.245 | 1.79 | 0.137 | 0 | 0 | 0 | 0 | 0 | 0 |
| 79. Other Utilities | | | 0.990 | 0.266 | 1.79 | 0.149 | 0 | 0 | 0 | 0 | 0 | 0 |
| 80. Wholesale Margins | | | 0.887 | 0.366 | 1.46 | 0.251 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81. Retail Margins | | | 1.318 | 0.674 | 1.58 | 0.426 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82. Imputed Rent-Owner Occ. Dwellings | | | 0.738 | 0.072 | 1.74 | 0.041 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83. Other Fin., Insurance, Real Estate | | | 0.786 | 0.255 | 1.74 | 0.146 | 0 | 0 | 0 | 0 | 0 | 0 |
| 84. Business Services | | | 0.765 | 0.362 | 1.36 | 0.266 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85. Education Services | | | 1.359 | 0.536 | 1.40 | 0.383 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86. Health Services | | | 1.429 | 0.378 | 1.84 | 0.205 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87. Amusement and Recr. Services | | | 1.085 | 0.511 | 1.79 | 0.286 | 0 | 0 | 0 | 0 | 0 | 0 |
| 88. Accommodation and Food Services | | | 1.160 | 0.633 | 1.69 | 0.376 | 0 | 0 | 0 | 0 | 0 | 0 |
| 89. Other Personal and Misc. Services | | | 1.197 | 0.581 | 1.58 | 0.367 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90. Transportation Margins | | | 0.596 | 0.219 | 1.57 | 0.140 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91. Operating, Office, Lab and Food | | | 0.581 | 0.249 | 1.36 | 0.183 | 0 | 0 | 0 | 0 | 0 | 0 |
| 92. Travel, Advertising and Promotion | | | 0.844 | 0.378 | 1.36 | 0.278 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sub-total | 3,000,000 | 500,000 | | | | | 1,001,000 | 158,500 | 1,159,500 | 27 | 4 | 31 |

Table 2
IMPACT OF PURCHASING GOODS/SERVICES FROM
AN ONTARIO MANUFACTURING OR SERVICE FIRM
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| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Agriculture (1-3) | | | 1.005 | 0.273 | 1.17 | 0.233 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2. Forestry (4) | | | 1.185 | 0.465 | 1.21 | 0.384 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3. Fishing, Hunting & Trapping (5-6) | | | 1.126 | 0.232 | 0.83 | 0.278 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4. Metal Mines (7,8) | | | 1.050 | 0.238 | 1.04 | 0.228 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5. Mineral Fuels (9-11) | | | 0.953 | 0.348 | 1.64 | 0.212 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6. Non-metal Mines (12) | | | 1.073 | 0.292 | 1.04 | 0.280 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7. Services Incidental to Mining (13) | | | 1.063 | 0.413 | 1.65 | 0.250 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8. Food & Beverage Industry (14-24) | | | 0.850 | 0.292 | 1.52 | 0.192 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9. Tobacco Products (25-26) | | | 0.980 | 0.288 | 1.84 | 0.157 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10. Rubber & Plastics (27-29) | | | 0.862 | 0.347 | 1.76 | 0.199 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11. Leather (30) | | | 0.809 | 0.460 | 1.40 | 0.330 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12. Textile (31-33) | | | 0.822 | 0.352 | 1.46 | 0.240 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13. Knitting Mills (34) | | | 0.918 | 0.519 | 1.46 | 0.355 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14. Clothing (35) | | | 0.900 | 0.479 | 1.51 | 0.318 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15. Wood (36-38) | | | 0.966 | 0.407 | 1.13 | 0.358 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16. Furniture & Fixtures (39) | | | 0.979 | 0.449 | 1.68 | 0.267 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17. Paper & Allied Products (40-42) | | | 0.943 | 0.316 | 1.65 | 0.192 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18. Printing & Publishing (43) | | | 1.120 | 0.461 | 1.81 | 0.254 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19. Primary Metal Products (45) | | | 0.791 | 0.268 | 1.32 | 0.203 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20. Metal Fabricating (46-50) | | | 0.965 | 0.379 | 1.54 | 0.246 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21. Machinery (51-54) | | | 0.852 | 0.326 | 1.27 | 0.256 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22. Transportation Equipment (55-57) | | | 0.618 | 0.224 | 1.53 | 0.146 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23. Electrical Products (58-59) | | | 0.929 | 0.354 | 1.44 | 0.245 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24. Non-metallic Minerals (60,61) | | | 0.972 | 0.337 | 1.77 | 0.191 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25. Petroleum & Coal Products (62,63) | | | 0.149 | 0.104 | 1.78 | 0.059 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26. Chemical & Chemical Industries(64-67) | | | 0.758 | 0.267 | 1.62 | 0.165 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27. Miscellaneous Manufacturing (68,69) | 500,000 | | 0.796 | 0.373 | 1.80 | 0.208 | 397,850 | 0 | 397,850 | 10 | 0 | 10 |

ENVIRONMENTAL PROTECTION IMPACT MODEL

| COMMODITY / INDUSTRY | ONE-TIME EXPENDITURE ($) | ANNUAL EXPENDITURE ($) | GDP MULTIPLIER | EMPLOYMENT MULTIPLIER (1979) | EMPLOYMENT DEFLATOR (1987) | EMPLOYMENT MULTIPLIER (1987) | ONE-TIME GDP IMPACT ($) | ANNUAL GDP IMPACT ($) | TOTAL GDP IMPACT ($) | ONE-TIME EMPLOYMENT IMPACT (person-years) | ANNUAL EMPLOYMENT IMPACT (person-years) | TOTAL EMPLOYMENT IMPACT (person-years) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28. Construction (70-73) | 1,000,000,000 | 500,000 | 1.029 | 0.367 | 1.41 | 0.261 | 1,029,000,000 | 514,500 | 1,029,514,500 | 26,076 | 13 | 26,089 |
| 29. Transportation and Storage (74) | | | 1.106 | 0.399 | 1.83 | 0.218 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30. Communication (75-77) | | | 1.322 | 0.501 | 1.57 | 0.319 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31. Electric Power, Gas (78,79) | | | 0.930 | 0.253 | 1.79 | 0.141 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32. Wholesale Trade (80) | | | 1.237 | 0.518 | 1.46 | 0.356 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33. Retail Trade (81) | | | 1.352 | 0.677 | 1.58 | 0.428 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34. Owner-Occupied Dwellings (82) | | | 0.738 | 0.072 | 1.74 | 0.042 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35. Other Finance, Insurance (83) | | | 1.098 | 0.351 | 1.74 | 0.201 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36. Education & Health (85,86) | | | 1.422 | 0.395 | 1.79 | 0.220 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37. Amusement & Recreation (87) | | | 1.099 | 0.519 | 1.79 | 0.289 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38. Services to Business (44,84) | | | 1.345 | 0.662 | 1.36 | 0.487 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39. Accomodation and Food (88) | | | 1.137 | 0.639 | 1.69 | 0.379 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40. Other Personal and Misc. Services(89) | | | 1.245 | 0.650 | 1.58 | 0.411 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41. Transportation Margins (90) | | | 0.711 | 0.253 | 1.57 | 0.162 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42. Operating, Office, Lab and Food (91) | | | 0.581 | 0.249 | 1.36 | 0.183 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43. Travel & Advertising (92) | | | 0.844 | 0.378 | 1.36 | 0.278 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sub-total | 1,000,500,000 | 500,000 | | | | | 1,029,397,850 | 514,500 | 1,029,912,350 | 26,087 | 13 | 26,100 |

Table 3
IMPACT OF IN-HOUSE EP EMPLOYMENT
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| COMMODITY / INDUSTRY | ONE-TIME EXPENDITURE ($) | ANNUAL EXPENDITURE ($) | GDP MULTIPLIER | EMPLOYMENT MULTIPLIER (1979) | EMPLOYMENT DEFLATOR (1987) | EMPLOYMENT MULTIPLIER (1987) | ONE-TIME GDP IMPACT ($) | ANNUAL GDP IMPACT ($) | TOTAL GDP IMPACT ($) | ONE-TIME EMPLOYMENT IMPACT (person-years) | ANNUAL EMPLOYMENT IMPACT (person-years) | TOTAL EMPLOYMENT IMPACT (person-years) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Services to Business | 45,000 | 60,000 | 1.832 | 1.543 | 1.36 | 1.134 | 82,440 | 109,920 | 192,360 | 5 | 7 | 12 |
| OVERALL TOTAL | 1,003,545,000 | 1,060,000 | | | | | 1,030,481,290 | 782,920 | 1,031,264,210 | 26,119 | 23 | 26,142 |

EMPLOYMENT DEFLATORS

| COMMODITY / INDUSTRY | GDP Deflator | GDP at Factor Cost ($1981 constant) 1979 | GDP at Factor Cost ($1981 constant) 1984 | GDP at Factor Cost (Current Dollars) 1979 | GDP at Factor Cost (Current Dollars) 1984 | Deflator 1984 | Deflator Current Year | Industry Price Indices | 1979 1971=100 | Current year (1987) 1981=100 | Link Factor | Current year (1987) 1971=100 | Current year Deflator |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64. Industrial Chemicals | | | | | | | | Chemical & Chemical Products Indust | 214.9 | 120.2 | 2.900 | 348.58 | 1.62 |
| 65. Fertilizers | | | | | | | | Agricultural Chemicals Industries | 229.0 | 102.2 | 2.810 | 287.18 | 1.25 |
| 66. Pharmaceuticals | | | | | | | | Pharmaceutical & Medicine Industry | 153.1 | 158.2 | 1.941 | 307.07 | 2.01 |
| 67. Other Chemical Products | | | | | | | | Chemical & Chemical Products Indust | 214.9 | 120.2 | 2.900 | 348.58 | 1.62 |
| 68. Scientific Equipment | Other Manufacturing Industries | 1,861.8 | 1,879.7 | 1,288.4 | 2,102.3 | 1.62 | 1.80 | | | | | | |
| 69. Other Manufactured Products | Other Manufacturing Industries | 1,861.8 | 1,879.7 | 1,288.4 | 2,102.3 | 1.62 | 1.80 | | | | | | |
| 70. Residential Construction | Construction | 21,440.6 | 23,460.7 | 17,551.8 | 24,316.0 | 1.27 | 1.41 | | | | | | |
| 71. Non-residential Construction | Construction | 21,440.6 | 23,460.7 | 17,551.8 | 24,316.0 | 1.27 | 1.41 | | | | | | |
| 72. Repair Construction | Construction | 21,440.6 | 23,460.7 | 17,551.8 | 24,316.0 | 1.27 | 1.41 | | | | | | |
| 73. Pipeline Construction | Construction | 21,440.6 | 23,460.7 | 17,551.8 | 24,316.0 | 1.27 | 1.41 | | | | | | |
| 74. Transportation and Storage | Transportation & Storage | 15,125.9 | 15,467.8 | 11,859.9 | 17,761.2 | 1.46 | 1.63 | | | | | | |
| 75. Radio and Television Broadcasting | Communication Industry | 7,396.7 | 9,196.6 | 6,887.9 | 12,094.6 | 1.41 | 1.57 | | | | | | |
| 76. Telephone and Telegraph | Communication Industry | 7,396.7 | 9,196.6 | 6,887.9 | 12,094.6 | 1.41 | 1.57 | | | | | | |
| 77. Postal Services | Communication Industry | 7,396.7 | 9,196.6 | 6,887.9 | 12,094.6 | 1.41 | 1.57 | | | | | | |
| 78. Electric Power | Other Utility Industries | 8,420.8 | 9,939.6 | 6,941.0 | 13,223.2 | 1.61 | 1.79 | | | | | | |
| 79. Other Utilities | Other Utility Industries | 8,420.8 | 9,939.6 | 6,941.0 | 13,223.2 | 1.61 | 1.79 | | | | | | |
| 80. Wholesale Margins | Wholesale Trade | 13,468.6 | 16,296.7 | 11,848.9 | 18,796.0 | 1.31 | 1.46 | | | | | | |
| 81. Retail Margins | Retail Trade | 19,738.1 | 21,362.9 | 15,584.3 | 24,034.8 | 1.42 | 1.58 | | | | | | |
| 82. Imputed Rent-Owner Occ. Dwellings | Owner-occupied Dwellings | 15,378.9 | 19,507.9 | 12,762.5 | 25,391.9 | 1.57 | 1.74 | | | | | | |
| 83. Other Fin., Insurance, Real Estate | Finance, Insurance & Real Estate Ind | 31,334.9 | 46,321.4 | 34,251.0 | 60,146.4 | 1.57 | 1.74 | | | | | | |
| 84. Business Services | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |
| 85. Education Services | Education Service Industries | 572.5 | 730.6 | 496.0 | 799.8 | 1.26 | 1.40 | | | | | | |
| 86. Health Services | Health Services Industries | 5,006.8 | 5,989.5 | 3,976.0 | 7,885.0 | 1.66 | 1.84 | | | | | | |
| 87. Amusement and Recr. Services | Amusement & Recreation Services | 1,785.0 | 1,963.5 | 1,490.1 | 2,647.7 | 1.62 | 1.79 | | | | | | |
| 88. Accommodation and Food Services | Accomodation & Food Services | 7,701.7 | 7,468.8 | 6,494.6 | 9,553.0 | 1.52 | 1.69 | | | | | | |
| 89. Other Personal and Misc. Services | Personal & Household Services | 1,980.4 | 2,441.6 | 1,636.4 | 2,876.9 | 1.43 | 1.58 | | | | | | |
| 90. Transportation Margins | Transportation Industries | 13,046.2 | 13,496.9 | 10,411.6 | 15,182.1 | 1.41 | 1.57 | | | | | | |
| 91. Operating, Office, Lab and Food | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |
| 92. Travel, Advertising and Promotion | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |

Table 2
IMPACT OF PURCHASING GOODS/SERVICES FROM
AN ONTARIO MANUFACTURING OR SERVICE FIRM

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Agriculture (1-3) | Agriculture & Related Services | 9,190.5 | 10,677.3 | 8,267.3 | 10,105.6 | 1.05 | 1.17 | | | | | | |
| 2. Forestry (4) | Logging & Forestry | 2,061.5 | 2,451.1 | 1,931.6 | 2,504.1 | 1.09 | 1.21 | | | | | | |
| 3. Fishing, Hunting & Trapping (5-6) | Fishing Hunting, & Trapping | 478.6 | 536.6 | 681.1 | 572.6 | 0.75 | 0.83 | | | | | | |
| 4. Metal Mines (7,8) | Mining Industries | 6,204.3 | 7,011.0 | 5,613.5 | 5,952.1 | 0.94 | 1.04 | | | | | | |
| 5. Mineral Fuels (9-11) | | | | | | | | Mineral Fuels | 133.1 | 93.9 | 2.326 | 218.41 | 1.64 |
| 6. Non-metal Mines (12) | Mining Industries | 6,204.3 | 7,011.0 | 5,613.5 | 5,952.1 | 0.94 | 1.04 | | | | | | |
| 7. Services Incidental to Mining (13) | Services Related to Mineral Extract | 1,545.5 | 1,9[illegible]3.1 | 1,237.8 | 2,354.1 | 1.48 | 1.65 | | | | | | |
| 8. Food & Beverage Industry (14-24) | | | | | | | | Food & Beverages Industries | 231.7 | 124.6 | 2.828 | 352.37 | 1.52 |
| 9. Tobacco Products (25-26) | | | | | | | | Tobacco Products Industries | 159.6 | 151.9 | 1.932 | 293.47 | 1.84 |
| 10. Rubber & Plastics (27-29) | | | | | | | | Miscellaneous Rubber Products Indus | 183.0 | 125.8 | 2.530 | 318.27 | 1.74 |
| 11. Leather (30) | | | | | | | | Leather & Allied Products Industrie | 239.3 | 128.2 | 2.604 | 333.83 | 1.40 |
| 12. Textile (31-33) | | | | | | | | Wool Yarn & Woven Cloth Industries | 204.9 | 120.6 | 2.485 | 299.69 | 1.46 |
| 13. Knitting Mills (34) | | | | | | | | Wool Yarn & Woven Cloth Industries | 204.9 | 120.6 | 2.485 | 299.69 | 1.46 |
| 14. Clothing (35) | | | | | | | | Men's & Boys' Clothing Industries | 196.0 | 121.8 | 2.426 | 295.49 | 1.51 |
| 15. Wood (36-38) | | | | | | | | Wood Industries | 260.8 | 121.8 | 2.430 | 295.97 | 1.13 |
| 16. Furniture & Fixtures (39) | | | | | | | | Furniture & Fixtures Industries | 208.9 | 132.8 | 2.645 | 351.26 | 1.68 |
| 17. Paper & Allied Products (40-42) | | | | | | | | Paper & Allied Products Industries | 239.6 | 128.3 | 3.083 | 395.55 | 1.65 |
| 18. Printing & Publishing (43) | Printing & Publishing | 2,890.1 | 3,154.7 | 2,318.8 | 4,134.4 | 1.63 | 1.81 | | | | | | |
| 19. Primary Metal Products (45) | | | | | | | | Primary Metal Industries | 258.8 | 112.8 | 3.031 | 341.90 | 1.32 |
| 20. Metal Fabricating (46-50) | | | | | | | | Fabricated Metal Products | 211.5 | 126.5 | 2.576 | 325.86 | 1.54 |
| 21. Machinery (51-54) | | | | | | | | Miscellaneous Machinery & Equipment | 198.6 | 129.1 | 2.495 | 253.20 | 1.27 |
| 22. Transportation Equipment (55-57) | | | | | | | | Motor Vehicle Parts & Accessories | 189.0 | 122.1 | 2.368 | 289.13 | 1.53 |
| 23. Electrical Products (58-59) | | | | | | | | Electrical and Electronic Products | 172.4 | 121.8 | 2.040 | 248.47 | 1.44 |
| 24. Non-metallic Minerals (60,61) | | | | | | | | Non Metallic Mineral Products Indus | 210.0 | 134.3 | 2.766 | 371.47 | 1.77 |
| 25. Petroleum & Coal Products (62,63) | | | | | | | | Refined Petroleum & Coal Products | 321.3 | 101.8 | 5.620 | 572.12 | 1.78 |
| 26. Chemical & Chemical Industries(64-67) | | | | | | | | Chemical & Chemical Products Indust | 214.9 | 120.2 | 2.900 | 348.58 | 1.62 |
| 27. Miscellaneous Manufacturing (68,69) | Other Manufacturing Industries | 1,861.8 | 1,879.7 | 1,288.4 | 2,102.3 | 1.62 | 1.80 | Total, All commodities | 217.9 | 110.4 | 2.694 | 297.42 | 1.36 |

## EMPLOYMENT DEFLATORS

| COMMODITY / INDUSTRY | GDP Deflator | GDP at Factor Cost ($1981 constant) 1979 | GDP at Factor Cost ($1981 constant) 1984 | GDP at Factor Cost (Current Dollars) 1979 | GDP at Factor Cost (Current Dollars) 1984 | Deflator 1984 | Deflator Current Year | Industry Price Indices | 1979 1971=100 | Current year (1987) 1981=100 | Link Factor | Current year (1987) 1971=100 | Current year Deflator |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28. Construction (70-73) | Construction | 21,440.4 | 23,460.7 | 17,551.8 | 24,316.0 | 1.27 | 1.41 | | | | | | |
| 29. Transportation and Storage (74) | Transportation | 13,046.2 | 13,496.9 | 10,411.6 | 17,761.2 | 1.65 | 1.83 | | | | | | |
| 30. Communication (75-77) | Communication Industry | 7,396.7 | 9,196.6 | 6,887.9 | 12,094.6 | 1.41 | 1.57 | | | | | | |
| 31. Electric Power, Gas (78,79) | Other Utility Industries | 8,420.8 | 9,939.6 | 6,961.0 | 13,223.2 | 1.61 | 1.79 | | | | | | |
| 32. Wholesale Trade (80) | Wholesale Trade | 13,468.6 | 16,294.7 | 11,848.9 | 18,796.0 | 1.31 | 1.46 | | | | | | |
| 33. Retail Trade (81) | Retail Trade | 19,738.1 | 21,362.9 | 15,584.3 | 26,034.8 | 1.42 | 1.58 | | | | | | |
| 34. Owner-Occupied Dwellings (82) | Owner-occupied Dwellings | 15,378.9 | 19,507.9 | 12,762.5 | 25,391.9 | 1.57 | 1.74 | | | | | | |
| 35. Other Finance, Insurance (83) | Finance, Insurance & Real Estate In | 41,354.9 | 46,321.4 | 34,251.0 | 60,146.4 | 1.57 | 1.74 | | | | | | |
| 36. Education & Health (85,86) | Education & Health Services (aggreg | 5,579.3 | 6,720.1 | 4,572.0 | 8,686.0 | 1.61 | 1.79 | | | | | | |
| 37. Amusement & Recreation (87) | Amusement & Recreation Services | 1,785.0 | 1,963.5 | 1,490.1 | 2,647.7 | 1.62 | 1.79 | | | | | | |
| 38. Services to Business (44,84) | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |
| 39. Accomodation and Food (88) | Accomodation & Food Services | 7,701.7 | 7,468.8 | 6,494.6 | 9,553.0 | 1.52 | 1.69 | | | | | | |
| 40. Other Personal and Misc. Services(89) | Personal & Household Services | 1,980.4 | 2,441.6 | 1,636.4 | 2,876.9 | 1.43 | 1.58 | | | | | | |
| 41. Transportation Margins (90) | Transportation Industries | 13,046.2 | 13,496.9 | 10,411.6 | 15,102.1 | 1.41 | 1.57 | | | | | | |
| 42. Operating, Office, Lab and Food (91) | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |
| 43. Travel & Advertising (92) | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 | | | | | | |

Table 3
IMPACT OF IN-HOUSE EP EMPLOYMENT
==========================================

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Services to Business | Business Service Industries | 7,380.9 | 11,264.4 | 7,103.2 | 13,270.8 | 1.22 | 1.36 |

| | 1984 | 1987 |
|---|---|---|
| GDP Implicit Price Index | 118.0 | 131.1 |

# APPENDIX III

# LISTING OF FIRMS IN THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY

2.6 (519) 621-99[illegible]
**3-L FILTERS LIMITED**
P.O. BOX 371

CAMBRIDGE ON, NIR 5V5
MR. JOHN A. KADAR

6.2 (613) 838-5655
**4D COMPUTER CONSULTING**
P.O. BOX 1289

RICHMOND ON, KOA 2Z0
MR. C.I. DUFFETT

3.1 (416) 789-1156
**A & A LIQUID WASTE REMOVAL**

1217 LAWRENCE AVENUE WEST
TORONTO ON, M6A IE2
IVOR SIMMONS
GENERAL MANAGER

2.6 (613) 962-9111
**A AND B PRECAST MFG LTD**
R.R. NO. 5

BELLEVILLE ON, K8N 4Z5
MR. C. ANDERSON
PRESIDENT

8.0 (519) 756-9840
**A REVZEN & CO LTD**
150 CLARENCE ST
P O BOX 271
BRANTFORD ON, N3T 2V8
SYD NORRIS

3.1 ( ) -
**A-1 SEWERAGE SERVICES LTD**
R R 5
HIGHWAY 17
THUNDER BAY ON, P7C 5M9

6.1 (519) 966-4006
**A.A. BOSCARIOL AND ASSOCIATES**
2881 WALKER ROAD

WINDSOR ON, N8W 3R2

6.2 (416) 487-4441
**A.A.C. APPOINTMENTS**
402-43 EGLINTON E.

TORONTO ON, M4P IA2
MR. CLIVE R. CROWE
PRESIDENT

6.1 (519) 344-1679
**A.B. BROGDEN LIMITED**
105 ONTARIO ST.

SARNIA ON, N7T IK9
MR. ALLAN BROGDEN
PRESIDENT

6.1 (416) 491-9508
**A.B. SCHWARTZ & ASSOCIATES INC.**
92 WHITEHORN CRES.

WILLOWDALE ON, M2J 3B2
MR. ARTHUR B. SCHWARTZ
PRESIDENT

6.1 (613) 822-1052
**A.J. GRAHAM ENGINEERING CONSULTANTS LTD**
2724 FENTON ROAD

GLOUCESTER ON, KIG 3N3

6.1 (613) 592-6060
**A.J. ROBINSON & ASSOCIATES INC**
CONSULTING ENGINEERS
P.O. BOX 13130
KANATA ON, K2K IX3
A J ROBINSON
PRESIDENT

6.1 (416) 446-1425
**A.P.D. & ASSOCIATES LTD.**
29 GERVIAS DRIVE,
SUITE 302
DON MILLS ON, M3C IY9
P R FURNESS
VICE PRESIDENT ENGINEERING

6.1 (416) 736-7070
**AASS AEROSPACE INC.**
1685 FLINT ROAD

DOWNSVIEW ON, M3J 2W8
MR. FRANCIS N. SHEN
GENERAL MANAGER

2.5 (416) 485-771
**ABART ENGINEERING LTD**

505 EGLINTON AVENUE WEST
TORONTO ON, M5N 1B2

2.5 (416) 747-9301
**ABC GROUP**
1 BRYDON DR.

REXDALE ON, M9W 4M7
MR. MIKE SCHMIDT

6.1 (705) 748-6316
**ABRICO ENERGY MANAGEMENT SERVICES LTD.**
P.O. BOX 1090

LAKEFIELD ON, KOL 2H0
DR. F.H. KRENZ
MANAGING DIRECTOR

2.7 (416) 438-3891
**ACADIA EQUIPMENT LTD**
2100 ELLESMERE RD
STE 208
SCARBOROUGH ON, M1H 3B7
JIM CHALLIS

3.1 (416) 223-436
**ACCURATE INDUSTRIAL WASTE LTD.**

163 JARDIN DRIVE
CONCORD ON, L4K 1X5
FRANK PASSER
OWNER

6.2 (416) 673-3377
**ACHIEVE ENTERPRISES LTD.**
WESTFIELD BUSINESS COURT
6315 SHAWSON DRIVE SUITE 7
MISSISSAUGA ON, L5T 1J2
MR. R.A. (ART) MCNEIL
PRESIDENT AND CEO

8.0 (519) 653-5031
**ACLO COMPOUNDERS INC**

498 EAGLE ST NORTH
CAMBRIDGE ON, N3H 4T3
D R YOUNG

6.1 (416) 595-2170
**ACRES DAVY MCKEE ENGINEERING INC.**
480 UNIVERSITY AVE.

TORONTO ON, M5G 1V2
MR. S. TIBSHIRANI
PRESIDENT

6.1 (416) 595-2000
**ACRES INTERNATIONAL LTD.**
480 UNIVERSITY AVENUE

TORONTO ON, M5G 1V2

2.6 (519) 853-1529
**ACTON PRECAST CONCRETE LIMITED**
R.R. #2

ACTON ON, L7J 2L8
MR. DAVID J. TURNER

6.0 (416) 483-6442
**ADJUDICATION SERVICES LIMITED**
2281 YONGE STREET,
SUITE 202
TORONTO ON, M4P 2C6
MICHEL G PICHER
PARTNER

6.2 (613) 563-1850
**ADLOG**
17 MARLBOROUGH

OTTAWA ON, K1N 8E6
M. KARL MCKINNON
PRESIDENT

2.6 (416) 299-3311
**AEF ALUMINUM STRUCTURES INC**

49 PASSMORE AVE
SCARBOROUGH ON, M1S 3B2

2.6 (416) 335-8944
**AER-O-FLO MANUFACTURING, HINDE MANUFACTURING**
1175 APPLEBY LINE, #C3
BURLINGTON ON, L7L 5H9
HARRY J. MARSHALL
PRESIDENT

2.6 (416) 781-5261
**AEROQUIP CANADA INC**

287 BRIDGELAND AVE
TORONTO ON, M6A 1Z7

6.2 (613) 737-3370
**AETOS INTERNATIONAL TRAINING GROUP INC.**
1379 BANK STREET

OTTAWA ON, K1H 8N3
MR. R.M. MEHAREY
PRESIDENT

2.6 (416) 745-6369
**AG TRONIC MFG LTD**

53 WESTMORE DR
REXDALE ON, M9V 3Y6

5.7 (613) 237-3022
**AGDA GROUP**
400-116 ALBERT ST.

OTTAWA ON, K1P 5G3
R.A. ALLAN
PRESIDENT

2.6 (613) 283-8424
**AGE INSTRUMENTS INC.**
P.O. BOX 15784 STATION "F"

OTTAWA ON, K2C 3S7
MR. ELLIS G. ASHWORTH

3.1 ( ) -
**AGGREGATE RECYCLING WESTERN INC**
15 ELIZABETH
COMBER ON, N0P 1J0

6.2 (519) 438-2101
**AGRANOVE ASSOCIATES LIMITED**
110 DUNDAS ST. SUITE 5

LONDON ON, N6A 1G1
DR. LARRY M. AGRANOVE
PRESIDENT

6.2 (613) 234-1781
**AGRODEV CANADA INC.**
222 SOMERSET STREET WEST
SUITE 600
OTTAWA ON, K2P 2G3
MR. R. BUCHANAN

2.7 (416) 741-5220
**AIM ZYTRON CORP.**

65 IRONDALE DRIVE
WESTON ON, M9L 2S6

8.0 (416) 878-2627
**AIMCO SOLBEC LTD.**

425 MORABEL DRIVE
MILTON ON, L9T 4N6
MARTIN O'MERA
MANAGER

6.1 (705) 445-3451
**AINLEY & ASSOCIATES LTD**

280 PRETTY RIVER PARKWAY
COLLINGWOOD ON, L9Y 4J5

2.5 (416) 335-5668
**AIR MIST CANADA LTD.**
3291 MAINWAY UNIT 5 & 6

BURLINGTON ON, L7M 1A6
MR. PHIL FITZPATRICK
VICE-PRESIDENT

2.7 (416) 791-2530
**AIR PRODUCTS**

2090 STEELES AVE
BRAMPTON ON, L6T 1A7
HENRY FRESE

2.5 (613) 932-5237
**AIR REFINER [CANADA] LIMITED**
115 BOUNDARY ROAD

CORNWALL ON, K6H 6H7
MR. H. DAHLSTROM
VICE PRESIDENT AND GM

2.5 (416) 664-5517
**AIR TRAC CORP.**
P.O. BOX 9099

STONEY CREEK ON, L8G 3X7
MR. M. VANDOORSLAER

4.1 (416) 791-1666
**AIRCRAFT APPLIANCES & EQUIPMENT LIMITED**
150 EAST DR.

BRAMALEA ON, L6T 1C1
MR. W.J. WHITE

2.5 (416) 624-2133
**AIRFLOW DEVELOPMENTS (CANADA)**

244 NEWKIRK ROAD
RICHMOND HILL ON, L4C 3G7

5.7 (416) 624-2133
**AIRFLOW DEVELOPMENTS LTD**
1281 MATHESON BLVD

MISSISSAUGA ON, L4W 1R1
BRIAN F. CORNWALL
PRESIDENT

2.7 (416) 683-9501
**AJAX MATERIAL HANDLING LIMITED**
570 FINLEY AVENUE

AJAX ON, L1S 2E3
MR. J.F. HANSEN
PRESIDENT

2.6 (416) 889-4923
**AL CORE FABRICATING CORP**

65 NEWKIRK RD
RICHMOND HILL ON, L4C 3G4

3.1 ( ) -
**AL LUCIER & SON SANITATION INC**

R R 1
MCGREGOR ON, N0R 1J0

2.6 (416) 741-5102
**ALBANY PUMP COMPANY LIMITED**
320 OAKDALE RD.

DOWNSVIEW ON, M3N 1W5
MR. R.S. BENNET
PRESIDENT

6.2 (416) 446-1425
**ALBERY, PULLERITS, DICKSON & ASSOCIATES**
29 GERVAIS DR
DON MILLS ON, M3C 1Y9

8.0 ( ) -
**ALCAN CANADA PRODUCTS LTD**
P O BOX 269
TORONTO DOMINION CENTRE
TORONTO ON, M5K 1K1
J GAGNE

2.10 (416) 632-8791
**ALCHEM INC.**
1055 TRUMAN ST.
BOX 5002
BURLINGTON ON, L7R 3Y9
MR. P.E. MCMANUS
PRESIDENT

2.10 (416) 273-3344
**ALCOA INTERNATIONAL CANADA LTD**
MISSISSAUGA EXECUTIVE CENTRE
2 ROBERT SPECK PKWY, SUITE 770
MISSISSAUGA ON, L4Z 1H8
STEVEN WAGNER

2.6 (416) 889-4923
**ALCORE FABRICATING CORP.**
65 NEWKIRK ROAD

RICHMOND HILL ON, L4C 3G4

2.6 (416) 474-550
**ALEXANDER D SMART LTD**

351 STEELCASE RD W. UNIT 3
MARKHAM ON, L3R 4H9

2.5 (416) 792-8005
**ALFA PLASTICS**
2 BAKER RD

BRAMPTON ON, L6T 4E3
MR. G. JUNGEBLUT

2.6 (416) 299-6101
**ALFA-LAVAL LIMITED**
INDUSTRY DIVISION,
101 MILNER AVENUE
SCARBOROUGH ON, M1S 4S6
DAVE NICHOLS
PRESIDENT

2.10 (416) 270-5534
**ALKARII CHEMICALS LTD.**

3265 WOLFEDALE ROAD
MISSISSAUGA ON, L5C 1V8
J C SCHILL
MANAGER, POLYMER DIVISION

2.6 (416) 669-1606
**ALL-RITE CUSTOM STEEL PRODUCTS [1978] LT**
171 MAPLECRETE ROAD

CONCORD ON, L4K 2B4
MR. S. DASGUPTA
PRESIDENT

2.6 (416) 669-1313
**ALLAN FYFE EQUIPMENT LTD**
261 BONES RD
CONCORD ON, L4K 1H8

6.2 (416) 362-1022
**ALLAN W. FOSTER & ASSOCIATES LIMITED**
80 FRONT ST. E. SUITE 605
TORONTO ON, M5E 1T4

3.1 ( ) -
**ALLEN GARNET CONSTRUCTION CO**
LTD
R R 8
KINGSTON ON, K7L 4V4

2.10 (416) 793-9473
**ALLIED COLLOIDS (CANADA) LTD.**
11 AUTOMATIC ROAD
BRAMPTON ON, L6S 4K6
PETER NICHOLS
SALES MANAGER

2.5 (416) 456-3432
**ALLIS-CHALMERS CANADA INC**
AAF DIVISION
34 HANSEN ROAD SOUTH
BRAMPTON ON, L6W 3H4
MR. WILLIAM E. MCQUADE
PLANT MANAGER

6.2 (416) 477-2133
**ALPHA CONTROLS AND INSTRUMENTATION**
361 STEELCASE RD
UNIT #3
MARKHAM ON, L3R 3V8
BRUCE BRADSHAW

7.0 (416) 449-2166
**ALPHA LABORATORIES**
285 LESMILL ROAD
DON MILLS ON, M3B 2V1
M SOOD

8.0 ( ) -
**ALPHANET LIMITED**
11 BOULTON AVENUE
TORONTO ON, M4M 2J4

6.2 (519) 433-3151
**ALTEX MANAGEMENT LIMITED**
199 QUEENS AVE. SUITE 200
LONDON ON, N6A 1J1
MR. KENNETH F. HEARD
PRESIDENT

8.0 (416) 476-7516
**ALUMINUM DROSS AND METAL**
RECYCLING CO
55 WATERLOO AVE
DOWNSVIEW ON, M3H 3Y1
LEON SNIATOWSKI

8.0 (416) 669-2347
**ALUMINUM REDUCTION CO**
31 FRESHWAY DR
CONCORD ON, L4K 1B1
I LISSACK

2.10 (416) 544-193
**ALUMPROCK RESOURCES LTD.**
52 IMPERIAL STREET
HAMILTON ON, L8L 7H2
BOB BROWN
OPERATOR

2.6 (416) 884-1423
**AMAC EQUIPMENT LIMITED**
110 INDUSTRIAL RD P O BOX 265
RICHMOND HILL ON, L4C 4Y2

8.0 (416) 366-3954
**AMALGAMET CANADA LTD**
P O BOX 95 COMMERCE COURT W
TORONTO ON, M5L 1C9
K V HANSEN

6.2 (519) 886-1763
**AMBIANCE INTERNATIONAL**
P.O. BOX 761
WATERLOO ON, N2J 4C2

2.10 (519) 252-2737
**AMCHEM PRODUCTS INC**
BOX 2097
WINDSOR/WALKERVILLE ON, N8Y 4R5
MR. B. JUSTIC
SALES MANAGER

2.7 (416) 451-9261
**AMERICAN HOIST OF CANADA LTD**
145 HEART LAKE ROAD S
BRAMPTON ON, L6W 3K3

6.2 (613) 234-0196
**AMERIE O'CONNELL LOGICAN INC.**
350 SPARKS ST. SUITE 1003
OTTAWA ON, K1R 7S8
DR. E.R. AMERIE
CHAIRMAN & C.E.O.

2.7 (519) 539-7475
**AMERTEK INC. (BELGIUM STANDARD IND.)**
P.O. BOX 865
WOODSTOCK ON, N4S 8A3
MR. WILLIAM C. THOMAS
PRESIDENT

2.7 (416) 279-1930
**AMI STEEGO LIMITED**
2520 HAINES ROAD
MISSISSAUGA ON, L4Y 1Y6

2.5 (416) 731-9274
**AMKO SYSTEMS INC**
57 PATRICE CRESCENT
THORNHILL ON, L4J 3R6
OHN KOSCH

6.2 (613) 728-1831
**AMTEK MANAGEMENT INC.**
493 RICHMOND ROAD
OTTAWA ON, K2A 0G3
MR. RON NASH
PRESIDENT

6.2 (613) 234-7711
**AMY E.A.C. & SONS LTD.**
SUITE 202-280 ALBERT ST
OTTAWA ON, K1P 5G8
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# APPENDIX IV

# MAIL SURVEY QUESTIONNAIRE

## SURVEY OF ONTARIO PRODUCERS OF ENVIRONMENTAL PROTECTION (EP) GOODS AND SERVICES

**Title/Position of Person Completing This Form:**

______________________________________________

**Products/Services:**
Using the EP product codes provided on the accompanying sheet, please show all the products or services your firm produces in Ontario. (Use the most narrowly-defined codes that apply.) For manufactured products, include only those with some Ontario content in manufacture or assembly, and omit products which you only distribute or repackage. Exclude equipment for which environmental protection uses do not constitute a significant portion of your sales.

| | **Product Code** | **Approx.1987 Share of Total EP Sales** |
|---|---|---|
| Highest Selling Product : | __________ | ________% |
| 2nd Highest Selling Product : | __________ | ________% |
| 3rd Highest Selling Product : | __________ | ________% |

All Other EP Products: (List Codes in rough order of importance):

____, ____, ____, ____, ____, ____, ____, ____, ____, ____,
____, ____, ____, ____, ____, ____, ____, ____, ____, ____,
____, ____, ____, ____, ____, ____, ____, ____, ____, ____.

If codes 112, 213, or 316 are listed anywhere above, please provide brief description of the product(s) in the space below (attach additional sheet if necessary.) Also, if you were in doubt as to which was the right code to use for any product, please describe the problem in the space below (or on additional sheet is necessary).

**Our Firm Does Not Produce EP Goods/Services in Ont.** ☐ ( If so, please Return Form Without Completing the Remaining Questions. Otherwise Please Continue.)

**PLEASE TURN OVER →**

**Employment:** We have roughly ☐ full-time employees (or equivalents) involved in producing EP goods and services in Ontario.

**5 Year Sales Revenue:** Our estimated sales revenue from Ontario-produced Environmental Protection goods and services, including exports and sales to other provinces: (ENTER ZERO WHERE APPROPRIATE)

| Year* | Codes 100-112 | Codes 200-213 | Codes 300-316 |
|---|---|---|---|
| 1983: | $____________ | $____________ | $____________ |
| 1984: | $____________ | $____________ | $____________ |
| 1985: | $____________ | $____________ | $____________ |
| 1986: | $____________ | $____________ | $____________ |
| 1987: | $____________ | $____________ | $____________ |

*Use fiscal year if calendar year data is not available.

**Exports:** We estimate that _______% of our EP sales revenue from our Ontario establishments in the most recent year was attributable to export sales outside of Canada.

**Ontario Content:** On average, the Ontario content of our Ontario-produced EP products and services is in excess of 50% of the production cost:

YES ☐ NO ☐

**Growth:** We expect our sales revenue from EP goods and services produced in Ontario to grow at a rate of __________% per year over the next 5 years (use negative rate if a decline is expected).

**If you would like a summary of the results of the survey,** enter your name and return address below. Individual responses will be kept strictly confidential.

**Name:** ____________________________________________

**Address:** ____________________________________________

____________________________________________

____________________________________________

**PRODUCT CODES:** Please use the most narrowly-defined codes applicable. Note that incinerators are listed by the type of waste burned, rather than under air pollution control. Noise pollution control and nuclear or radioactive waste management are excluded from the terms of reference for this study.

## Air Pollution Control/Monitoring

| | |
|---|---|
| Electrostatic Precipitators, Precipitator Controls and Conditioners, Electrostatically Augmented Devices, Sonic Horns, Settling Chambers, Catalytic Equipment | 100 |
| Wet/Dry Scrubbers and Washers, Nozzles | 101 |
| Baghouses, cloth and fibre filters, special filter media and leak detectors | 102 |
| Cyclones, Mechanical Centrifugals and Impingement Separators | 103 |
| Flares | 104 |
| Gas Absorption Equipment | 105 |
| Vapour Condensation Equipment | 106 |
| Odour Counteractants/Destructors | 107 |
| Sampling/Collecting Instruments (Samplers, Collectors, Impactors, Dust Jars, Gas Sampling Pumps and Hoses, and Personal Monitors) | 108 |
| Analytical Instruments/Equip (Mass Spectrometry, Chemilluminescence, Infrared, Calibration Devices, etc.) | 109 |
| Other Instruments (meters, combustion monitors, telemetry equip. etc.) | 110 |
| Consulting, Monitoring and Testing Services | 111 |
| Other Air Pollution Products/Services (include description on reverse) | 112 |

## Water/Wastewater Treatment

| | |
|---|---|
| Aerators | 200 |
| Agitators and Mixers | 201 |
| Gravity Sedimentation Systems Equip. (Clarifiers, Flocculators, Lagoons, etc) | 202 |
| Filters, Screens, Strainers | 203 |
| Centrifuges | 204 |
| Chemical Feeding and Mixing Equip. (Chlorination etc.) | 205 |
| Sludge Processing Equipment (collectors, conveyors, digesters, incinerators, shredders, thickeners and disposal units such as heat treatment, wet-air oxid. or pressure filter) | 206 |
| Liquid Waste Incinerators | 207 |
| Instruments (testing, measuring, and control instr., meters, gauges, analyzers) | 208 |
| Chemicals and other supplies | 209 |
| Consulting, Testing Services | 210 |
| Specialized Pumps, blowers, valves and other water system components – exclude equipment for which EP uses are not a major application) | 211 |
| Private Water Treatment Systems | 212 |
| Other Water/Wastewater equipment or services (include description on reverse) | 213 |

## Solid Waste Disposal/Treatment

| | |
|---|---|
| Bailers | 300 |
| Compactors, Crushers, Grinders, Pulverizers, Shredders, Packers | 301 |
| Composting Plants | 302 |
| Containers | 303 |
| Transfer Stations | 304 |
| Hoppers, Conveyers | 305 |
| Solid Waste Incinerators | 306 |
| Loaders | 307 |
| Recycling/Resource Recovery Equip. | 308 |
| Vehicles, Bodies and Trailers | 309 |
| Waste Disposal Systems | 310 |
| Vacuum Equipment | 311 |
| Magnetic Systems | 312 |
| Solid & Toxic Waste Disposal Services | 313 |
| Recycling Services | 314 |
| Consulting Services | 315 |
| Other Solid Waste equipment or services (incl. description on reverse). | 316 |

# ANNOTATED BIBLIOGRAPHY

*Canadian Recyclers Directory 1987-88*. (Recoup Publishing: Ottawa) Fourth edition.

This annual publication lists suppliers of recycling services and equipment by type of product or service provided and by province, and also includes a glossary of terms relating to recycling. The document also includes a description of the Canadian Association of Recycling Industries, who represent 300 companies generating $1.5 to $2 billion in sales and employing 8,000 workers across Canada.

Cox, David, and Richard Harris (1984). "A quantitative assessment of the economic impact on Canada of sectoral free trade with the United States". Ontario Economic Council Working Paper. (OEC: Toronto).

This paper uses a general equilibrium trade model to measure the industry level impacts of sectoral free trade and comprehensive free trade between Canada and the United States.

Department of Regional Industrial Expansion (1986). *Competitiveness Profile: Environmental Equipment*. (Ottawa: mimeo).

This report assesses the competitiveness of Canadian environmental equipment manufacturers relative to their counterparts in the United States, including makers of equipment for potable and wastewater treatment, air pollution control, solid waste handling and noise pollution abatement. Partial statistics from Statistics Canada data are reported for sales and imports of these products, and factors affecting the current trade performance are identified.

Department of Regional Industrial Expansion (1987a). *Capital Investment Intentions Survey*. (Ottawa).

Reports on a survey of investment spending intentions of large, Canadian firms.

Department of Regional Industrial Expansion (1987b). *Environmental Equipment Industry*. (Ottawa: mimeo)

This report profiles certain aspects of the Canadian environmental equipment industry, and reports estimates for imports and exports of EP equipment, based on the available Statistics Canada data.

Environment Canada (1987). *International Opportunities for Canada's Environmental Industry*. (Ottawa: mimeo).

This report assessed the opportunities for Canadian exports of goods and services used for environmental protection and conservation. It concluded that the industry in Canada is extremely capable but very diffuse, that international markets provide a good opportunity to mobilize this industry, and that market opportunities relate to the provision or rehabilitation of public health engineering facilities, and developing areas in conservation, reclamation, hazardous waste management and environmental assessment. Funding assistance is already available through CIDA, the World Bank, and some provincial government programs.

Environment Directorate, Organization for Economic Cooperation and Development. *The Promotion and Diffusion of Clean Technologies in Industry*. (OECD: Paris, France: mimeo).

This report highlights international obstacles to the diffusion of clean technologies in industry and the present policies in place in OECD countries to promote their use. It finds that clean technologies have thus far seen limited use, and advocates a cooperative effort between industry and government to develop incentives in an integrated industrial and environmental policy.

Federation of Associations on the Canadian Environment (FACE) (1984). *The Water Pollution Industry: A Strategic Profile*. (Ottawa, Ontario).

This report presents the results of a Statistical Analysis of Statistics Canada data on expenditures on waterworks and sewage treatment facilities, together with the results of a survey of 43 firms in this sector. The study included firms supplying the full range of equipment and services for these fluid systems, including pumps, valves, pipes and tanks, as well as specialized EP equipment. Case studies are presented on four firms in this sector.

Glenn, William M. (1987a). *Environmental Protection Industry Inventory of Firms*. (Corpus Information Service of Southam Communications: Don Mills, Ontario: mimeo).

This document provides a listing of 2,777 EP industry firms across Canada, drawn from trade journals, trade association membership directories, and other listings.

Glenn, William M. (1987b). *Jobs and the Environment: Some Preliminary Number Crunching*. (Corpus Information Service of Southam Communications: Don Mills, Ontario: mimeo).

This paper attempts to use a mix of public and private sector data and various rules-of-thumb to measure the total private and public sector employment generated in the widely defined environmental protection industry. Across Canada, the paper estimates that total employment is on the order of 125,000 to 150,000, with governments accounting for one-third of the total. Income tax data on accelerated capital cost allowance claims on pollution control equipment formed the basis for some of the estimates; Woods Gordon was advised by federal government officials that the data could not be reliably used for this purpose.

Institute for Research on Public Policy (1987). *Defining the Environmental Protection Industry*. (IRPP: Ottawa, Ontario).

This report surveys the available data sources on the Canadian environmental protection industry, and concludes that only limited data are currently available. Two approaches for developing additional data are recommended: a survey of purchasers and a survey of suppliers, but the development of comprehensive data is thought to be a task best suited for Statistics Canada. The report also recommends the use of Input-Output analysis as a tool to model the economic impacts of EP spending, and reviews the possibilities for the the use of other analytical techniques (cost-benefit analysis, macroeconomic modelling, general equilibrium models) that generally have more stringent data requirements.

Maclaren, James F. Ltd. (1979) *Potential for Expansion of the Pollution Equipment Manufacturing System*. (Willowdale, Ontario)

This report estimated the size of the pollution control equipment industry in Canada in 1978 at $369 million in sales, based on a series of 275 interviews. Exports were found to be low, but the export market was cited as the major opportunity for expansion of the the Canadian industry.

Management Information Systems Inc. (1986) *Economic and Employment Benefits of Investments in Environmental Protection*. (Washington, D.C.)

This report uses an input-output model to estimate the employment and income generated by expenditures on environmental protection in the United States.

Ontario Ministry of Treasury and Economics (1986). *Ontario Statistics*. (Toronto, Ontario)

This book provides general economic statistics for Ontario.

Ropes, Allison L. and William T. Lorenz (1986) *1986 Update: Water Pollution Control Industry Outlook*. (William T. Lorenz and Company: Concord, New Hampshire)

This document presents a comprehensive report on the status of, and outlook for, the U.S. water pollution control industry. It includes a discussion of the growth prospects of each segment of the industry (industrial, municipal, etc.).

Smith, R.E. (1978). *The Pollution Control Industry in Ontario*. (Ministry of the Environment, Program Planning and Evaluation Branch, Toronto).

This report analyzes the historical demand for pollution control in Ontario, makes projections for future demand, assesses the structure of, and problems facing, the Ontario EP equipment industry and makes recommendations designed to increase the future Canadian content of EP purchases in Canada. The report estimates that imports accounted for 38% of the $189.3 million in Canadian EP equipment spending in 1977. Only air and water treatment equipment are covered. Certificates of Approval Data were used to track expenditures and the installed equipment base. The report concluded that air pollution equipment manufacturing accounted for 795 jobs, and that in total, including construction, design, importing and supplies, the air pollution sector employed 1,671 Ontarians in 1978. Total water treatment employment, primarily in construction and in operating municipal and provincial treatment facilities, was estimated at close to 19,000. Opportunities for improving domestic content include ensuring that duty remissions are restricted to equipment truly not available in Canada, attacking U.S. trade barriers posed by the Buy America provisions in the Clean Water Act, promoting Canadian made products and creating an enhanced awareness of Canadian alternatives to imports among buyers. The report also recommended provincial government financial support for new Canadian equipment.

Statistics Canada (1987a). *Construction in Canada: 1985-87*. (Minister of Supply and Services Canada: Ottawa) Catalogue 64-201.

This publication provides data on expenditures on waterworks and sewage systems by private and public organizations.

Statistics Canada. (1987b) *The Daily, July 3, 1987*. (Statistics Canada: Ottawa). Catalogue 11-001E.

This edition of the Daily reported on Capital Expenditures on Machinery and Equipment in Canada, which includes a category for Pollution Abatement and Control.

Stothart, Paul. (1985) "Medium Term Status Report on the Pollution Control Equipment Foreign Investment Prospecting Project". (Department of Regional Industrial Expansion: mimeo)

This document reports on the initial stages of efforts by DRIE to stimulate Canadian manufacturing by global EP equipment manufacturers. The report includes a brief review of the status of the EP equipment manufacturing industry in Canada, and the export market potential.

Task Force on Environmental Technologies (1983) *Report to the Minister of State for Science and Technology*. (Minister of Supply and Services Canada: Ottawa)

This report examines the possibilities for economic benefits from the development of new technologies for environmental protection. It identified promising opportunities in monitoring and testing equipment, remote data gathering, automated control technologies and pollution control equipment designed for use in frontier regions, as well as the development of new processes for municipal wastewaters and solid waste. Factors inhibiting domestic R&D in environmental protection include the fact that many of the manufacturers are small branches of multinationals who do research in their home countries, and the fact that the environmental protection aspect of a new facility is a small portion of the total cost and is therefore not given a great deal of attention in design. The regulatory process is also thought to promote conservatism by favouring the use of proven technologies. The Task force recommended government financial assistance for prototype installations, and other methods for increasing the degree of innovation in Canada.

*Water and Pollution Control*. (Southam Business Publication) Quarterly.

This trade journal publishes and annual buyers directory, which includes a listing of firms providing equipment and services for water and wastewater treatment. The November/December 1979 edition also included a survey article on environmental spending in Canada.